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RUGGEDCOM ROS v3.12

User Guide

For RS416

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Preface

This guide describes the ROS v running on the RUGGEDCOM RS416 family of products. It contains instructions and guidelines on how to use the software, as well as some general theory.

It is intended for use by network technical support personnel who are familiar with the operation of networks. It is also recommended for us by network and system planners, system programmers, and line technicians.

About This Guide

This guide is intended for use by network technical support personnel who are familiar with the operation of networks. It is also recommended for us by network and system planners, system programmers, and line technicians.

Conventions

This User Guide Guide uses the following conventions to present information clearly and effectively.

Alerts

The following types of alerts are used when necessary to highlight important information.

DANGER!
DANGER alerts describe imminently hazardous situations that, if not avoided, will result in death or serious injury.

WARNING!
WARNING alerts describe hazardous situations that, if not avoided, may result in serious injury and/or equipment damage.

CAUTION!
CAUTION alerts describe hazardous situations that, if not avoided, may result in equipment damage.

IMPORTANT!
IMPORTANT alerts provide important information that should be known before performing a procedure or step, or using a feature.

NOTE
NOTE alerts provide additional information, such as facts, tips and details.

CLI Command Syntax

The syntax of commands used in a Command Line Interface (CLI) is described according to the following conventions:

Example	Description
command	Commands are in bold.
command parameter	Parameters are in plain text.
command parameter1 parameter2	Alternative parameters are separated by a vertical bar (|).
command parameter1 *parameter2*	Parameters in italics must be replaced with a user-defined value.
command [parameter1 | parameter2]	Square brackets indicate a required choice between two or more parameters.
command { parameter3 | parameter4 }	Curly brackets indicate an optional parameter(s).
command parameter1 parameter2 { parameter3 | parameter4 }	All commands and parameters are presented in the order they must be entered.

Related Documents

Other documents that may be of interest include:

- *ROS Installation Guide for RUGGEDCOM RS416*
- *RUGGEDCOM Fiber Guide*
- *RUGGEDCOM Wireless Guide*
- *White Paper: Rapid Spanning Tree in Industrial Networks*

System Requirements

Each workstation used to connect to the ROS interface must meet the following system requirements:

- Must have one of the following Web browsers installed:
  - Microsoft Internet Explorer 8.0 or higher
  - Mozilla Firefox
  - Google Chrome
  - Iceweasel/IceCat (Linux Only)
- Must have a working Ethernet interface compatible with at least one of the port types on the RUGGEDCOM device
- The ability to configure an IP address and netmask on the computer's Ethernet interface

Accessing Documentation

The latest Hardware Installation Guides and Software User Guides for most RUGGEDCOM products are available online at www.siemens.com/ruggedcom.

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1 Introduction

Section 1.1
Security Considerations

Section 1.1.1
Security Recommendations

To prevent unauthorized access to the device, note the following security recommendations:

- Do not connect the device directly to the Internet. The device should be operated inside a secure network perimeter.
- Replace the default passwords for the standard *admin*, *operator* and *guest* accounts before the device is deployed.
- Use strong passwords. For more information about creating strong passwords, refer to the password requirements in Section 2.10, “Passwords”.
- Create and provision custom SSL certificates and SSH keys in order to establish a chain of trust that you yourself can verify.
- SSL and SSH private keys are accessible to users who connect to the device via the serial console. Make sure to take appropriate precautions when shipping the device beyond the boundaries of the trusted environment:
  - Replace the SSH and SSL keys with *throwaway* keys prior to shipping.
  - Take the existing SSH and SSL keys out of service. When the device returns, create and program new keys for the device.
- Control access to the serial console to the same degree as any physical access to the device. Access to the serial console allows for potential access to the ROS boot loader, which includes tools that may be used to gain complete access to the device.
- Only enable the services that will be used on the device.
- If SNMP is enabled, limit the number of IP addresses that can connect to the device and change the community names. Also configure SNMP to raise a trap upon authentication failures.
- Avoid using insecure services such as Telnet and TFTP, or disable them completely if possible. These services are available for historical reasons and are disabled by default.
- Limit the number of simultaneous Web Server, Telnet and SSH sessions allowed.
- Configure remote system logging to forward all logs to a central location.
- Periodically audit the device to make sure it complies with these recommendations and/or any internal security policies.
- Configuration files are provided in the CSV (comma separated values) format for ease of use. Make sure that configuration files are properly protected.
- Management of the configuration file, certificates and keys is the responsibility of the device owner. Before returning the device to Siemens' for repair, make sure encryption is disabled (to create a cleartext version of

the configuration file) and replace the current certificates and keys with temporary certificates and keys that can be destroyed upon the device's return.

Section 1.1.2
Key Files

This section describes in detail the security keys used by ROS for the establishment of secure remote login (SSH) and web access (SSL).

It is strongly recommended to create and provision your own SSL certificates and SSH keys. The default certificate and keys are only ever used when upgrading to ROS v3.12.0 or later. New ROS-based units from Siemens' will already have unique certificate and keys preconfigured in `ssl.crt` and `ssh.keys` flash files.

The default and auto-generated SSL certificate are self-signed. It is recommended to use SSL certificates that are either signed by a trusted third party Certificate Authority (CA) or by an organization's own CA. This technique is described in the Siemens' application note: *Creating/Uploading SSH Keys and SSL Certificates to ROS Using Windows*, available from www.siemens.com/ruggedcom.

The sequence of events related to Key Management during an upgrade to ROS v3.12.0 or later is as follows:

NOTE
The auto-generation of SSH keys is not available for Non-Controlled (NC) versions of ROS.

- Upgrade Boot Software to v2.20.0 or newer (see Section 1.1.3, “Bootloader Considerations”).
- On first boot, ROS >= v3.12.0 will start the SSH and SSL (secure web) services using the *default keys*.
- Immediately after boot, ROS will start to generate a unique SSL certificate and SSH key pair, and save each one to its corresponding flash file. This process will take approximately one hour on a lightly loaded unit. As each one is created, the corresponding service is immediately restarted with the new keys.
- At any time during the key generation process, one may upload custom keys, which will take precedence over both the default and auto-generated keys and will take effect immediately.
- On subsequent boot, if there is a valid `ssl.crt` file, the default certificate will not be used for SSL. If there is a valid `ssh.keys` file, the default SSH key will not be used.
- At any time, new keys may be uploaded or generated by ROS using the "sslkeygen" or "sshkeygen" CLI commands.

Section 1.1.2.1
SSL Certificates

ROS supports SSL certificates that conform to the following specifications:

- X.509 v3 digital certificate format
- PEM format
- RSA key pair, 512 to 2048 bits in length

The RSA key pair used in the default certificate and in those generated by ROS uses a public key of 1024 bits in length.

NOTE
RSA keys smaller than 1024 bits in length are not recommended. Support is only included here for compatibility with legacy equipment.

NOTE
The default certificate and keys are common to every instance of a given ROS firmware version. That is why it is important to either allow the key autogeneration to complete or to provision custom keys. In this way, one has at least unique, and at best, traceable and verifiable keys installed when establishing secure communication with the unit.

NOTE
RSA key generation times increase dramatically with key length. 1024-bit RSA keys take O(10 minutes) on a lightly loaded unit, whereas 2048-bit keys take O(2 hours). A typical modern PC system, however, can generate these keys in seconds.

The following (bash) shell script fragment uses the `openssl` command line utility to generate a self-signed X.509 v3 SSL certificate with a 1024-bit RSA key suitable for use in ROS. Note that two standard PEM files are required: the SSL certificate and the RSA private key file. These are concatenated into the resulting `ssl.crt` file, which may then be uploaded to ROS:

```
# RSA key size:
BITS=1024
# 20 years validity:
DAYS=7305

# Values that will be stored in the Distinguished Name fields:

COUNTRY_NAME=CA                    # Two-letter country code
STATE_OR_PROVINCE_NAME=Ontario     # State or Province
LOCALITY_NAME=Concord              # City
ORGANIZATION=Ruggedcom.com         # Your organization's name
ORGANIZATION_CA=${ORGANIZATION}_CA # Your Certificate Authority
COMMON_NAME=RC                     # The DNS or IP address of the ROS unit
ORGANIZATIONAL_UNIT=ROS            # Organizational unit name

# Variables used in the construction of the certificate
REQ_SUBJ="/C=${COUNTRY_NAME}/ST=${STATE_OR_PROVINCE_NAME}/L=${LOCALITY_NAME}/O=${ORGANIZATION}/OU=
${ORGANIZATIONAL_UNIT}/CN=${COMMON_NAME}/"
REQ_SUBJ_CA="/C=${COUNTRY_NAME}/ST=${STATE_OR_PROVINCE_NAME}/L=${LOCALITY_NAME}/O=${ORGANIZATION_CA}/
OU=${ORGANIZATIONAL_UNIT}/"

#########################################################################
# Make the self-signed SSL certificate and RSA key pair:

openssl req -x509 -newkey rsa:${BITS} -nodes \
 -days ${DAYS} -subj ${REQ_SUBJ} \
 -keyout ros_ssl.key  \
 -out    ros_ssl.crt

# Concatenate Cert and Key into a single file suitable for upload to ROS:
# Note that cert must precede the RSA key:
cat  ros_ssl.crt  ros_ssl.key > ssl.crt
```

For information on creating SSL certificates for use with ROS in a Microsoft Windows environment, refer to the following Siemens' application note: *Creating/Uploading SSH Keys and SSL Certificates to ROS Using Windows*.

The following listing is the disassembly of a self-signed SSL certificate generated by ROS:

```
Certificate:
    Data:
```

```
        Version: 3 (0x2)
        Serial Number:
            ca:01:2d:c0:bf:f9:fd:f2
        Signature Algorithm: sha1WithRSAEncryption
        Issuer: C=CA, ST=Ontario, L=Concord, O=RuggedCom.com, OU=RC, CN=ROS
        Validity
            Not Before: Dec  6 00:00:00 2012 GMT
            Not After : Dec  7 00:00:00 2037 GMT
        Subject: C=CA, ST=Ontario, L=Concord, O=RuggedCom.com, OU=RC, CN=ROS
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
            RSA Public Key: (1024 bit)
                Modulus (1024 bit):
                    00:83:e8:1f:02:6b:cd:34:1f:01:6d:3e:b6:d3:45:
                    b0:18:0a:17:ae:3d:b0:e9:c6:f2:0c:af:b1:3e:e7:
                    fd:f2:0e:75:8d:6a:49:ce:47:1d:70:e1:6b:1b:e2:
                    fa:5a:1b:10:ea:cc:51:41:aa:4e:85:7c:01:ea:c3:
                    1e:9e:98:2a:a9:62:48:d5:27:1e:d3:18:cc:27:7e:
                    a0:94:29:db:02:5a:e4:03:51:16:03:3a:be:57:7d:
                    3b:d1:75:47:84:af:b9:81:43:ab:90:fd:6d:08:d3:
                    e8:5b:80:c5:ca:29:d8:45:58:5f:e4:a3:ed:9f:67:
                    44:0f:1a:41:c9:d7:62:7f:3f
                Exponent: 65537 (0x10001)
        X509v3 extensions:
            X509v3 Subject Key Identifier:
                EC:F3:09:E8:78:92:D6:41:5F:79:4D:4B:7A:73:AD:FD:8D:12:77:88
            X509v3 Authority Key Identifier:
                keyid:EC:F3:09:E8:78:92:D6:41:5F:79:4D:4B:7A:73:AD:FD:8D:12:77:88
                DirName:/C=CA/ST=Ontario/L=Concord/O=RuggedCom.com/OU=RC/CN=ROS
                serial:CA:01:2D:C0:BF:F9:FD:F2
            X509v3 Basic Constraints:
                CA:TRUE
    Signature Algorithm: sha1WithRSAEncryption
        64:cf:68:6e:9f:19:63:0e:70:49:a6:b2:fd:09:15:6f:96:1d:
        4a:7a:52:c3:46:51:06:83:7f:02:8e:42:b2:dd:21:d2:e9:07:
        5c:c4:4c:ca:c5:a9:10:49:ba:d4:28:fd:fc:9d:a9:0b:3f:a7:
        84:81:37:ca:57:aa:0c:18:3f:c1:b2:45:2a:ed:ad:dd:7f:ad:
        00:04:76:1c:f8:d9:c9:5c:67:9e:dd:0e:4f:e5:e3:21:8b:0b:
        37:39:8b:01:aa:ca:30:0c:f1:1e:55:7c:9c:1b:43:ae:4f:cd:
        e4:69:78:25:5a:a5:f8:98:49:33:39:e3:15:79:44:37:52:da:
        28:dd
```

Section 1.1.2.2

SSH Key Pairs

Controlled versions of ROS support SSH public/private key pairs that conform to the following specifications:

- PEM format
- DSA key pair, 512 to 2048 bits in length

The DSA key pair used in the default key pair and in those generated by ROS uses a public key of 1024 bits in length.

NOTE
DSA keys smaller than 1024 bits in length are not recommended, and support is only included here for compatibility with legacy equipment.

NOTE
DSA key generation times increase dramatically with key length. 1024-bit DSA keys take approximately 50 minutes on a lightly loaded unit, whereas 2048-bit keys take approximately 4 hours. A typical modern PC system, however, can generate these keys in seconds.

The following (bash) shell script fragment uses the `ssh-keygen` command line utility to generate a 1024-bit DSA key suitable for use in ROS. The resulting `ssh.keys` file, which may then be uploaded to ROS:

```
# DSA key size:
BITS=1024

# Make an SSH key pair:
ssh-keygen -t dsa -b 1024 -N '' -f ssh.keys
```

The following listing is the disassembly of a self-signed SSL certificate generated by ROS:

```
Private-Key: (1024 bit)
priv:
    00:b2:d3:9d:fa:56:99:a5:7a:ba:1e:91:c5:e1:35:
    77:85:e8:c5:28:36
pub:
    6f:f3:9e:af:e6:d6:fd:51:51:b9:fa:d5:f9:0a:b7:
    ef:fc:d7:7c:14:59:52:48:52:a6:55:65:b7:cb:38:
    2e:84:76:a3:83:62:d0:83:c5:14:b2:6d:7f:cc:f4:
    b0:61:0d:12:6d:0f:5a:38:02:67:a4:b7:36:1d:49:
    0a:d2:58:e2:ff:4a:0a:54:8e:f2:f4:c3:1c:e0:1f:
    9b:1a:ee:16:e0:e9:eb:c8:fe:e8:16:99:e9:61:81:
    ed:e4:f2:58:fb:3b:cb:c3:f5:9a:fa:ed:cd:39:51:
    47:90:5d:6d:1b:27:d5:04:c5:de:57:7e:a7:a3:03:
    e8:fb:0a:d5:32:89:40:12
P:
    00:f4:81:c1:9b:5f:1f:eb:ac:43:2e:db:dd:77:51:
    6e:1c:62:8d:4e:95:c6:e7:b9:4c:fb:39:9c:9d:da:
    60:4b:0f:1f:c6:61:b0:fc:5f:94:e7:45:c3:2b:68:
    9d:11:ba:e1:8a:f9:c8:6a:40:95:b9:93:7c:d0:99:
    96:bf:05:2e:aa:f5:4e:f0:63:02:00:c7:c2:52:c7:
    1a:70:7c:f7:e5:fe:dd:3d:57:02:86:ae:d4:89:20:
    ca:4b:46:80:ea:de:a1:30:11:5c:91:e2:40:d4:a3:
    82:c5:40:3b:25:8e:d8:b2:85:cc:f5:9f:a9:1d:ea:
    0a:ac:77:95:ee:d6:f7:61:e3
Q:
    00:d5:db:48:18:bd:ec:69:99:eb:ff:5f:e1:40:af:
    20:80:6d:5c:b1:23
G:
    01:f9:a1:91:c0:82:12:74:49:8a:d5:13:88:21:3e:
    32:ea:f1:74:55:2b:de:61:6c:fd:dd:f5:e1:c5:03:
    68:b4:ad:40:48:58:62:6c:79:75:b1:5d:42:e6:a9:
    97:86:37:d8:1e:e5:65:09:28:86:2e:6a:d5:3d:62:
    50:06:b8:d3:f9:d4:9c:9c:75:84:5b:db:96:46:13:
    f0:32:f0:c5:cb:83:01:a8:ae:d1:5a:ac:68:fb:49:
    f9:b6:8b:d9:d6:0d:a7:de:ad:16:2b:23:ff:8e:f9:
    3c:41:16:04:66:cf:e8:64:9e:e6:42:9a:d5:97:60:
    c2:e8:9e:f4:bc:8f:6f:e0
```

Section 1.1.3
Bootloader Considerations

NOTE
ROS Key Management features require Boot Software v2.20.0 at minimum. It is strongly recommended to update the bootloader to this version or higher.

NOTE
If a Boot upgrade is required from Boot v2.15.0 or older, it is recommended to run the "flashfiles defrag" command from the CLI Shell prior to the bootloader upgrade.

In the event that it is impracticable to update the bootloader to v2.20.0 or higher, some of the key management features will nevertheless be available, although in a degraded mode. A ROS system running Main Software v and Boot Software earlier than v2.20.0 will have the following behaviour:

- The unit will use the default keys after every reset, and immediately begin generating `ssl.crt` and `ssh.keys`. It will *not*, however, write these files to flash.
- The unit will accept user-uploaded `ssl.crt` and `ssh.keys`, but again, it will *not* write these files to flash.

WARNING!
If ROS Boot Software earlier than v2.20.0 runs and creates log entries, there is the possibility that it will overflow into an area of Flash memory that is reserved by ROS Main Software v or newer for keys. If this were to occur, some syslog data would not be readable by Main.

In the even more unlikely event that ROS Boot Software v2.20.0 or newer had been installed and Main had written the `ssl.crt` and `ssh.keys` files, and the unit had subsequently had a downgrade to Boot Software earlier than v2.20.0, there is a possibility similar to the warning above, whereby Boot logging could possibly overwrite and therefore destroy one or both installed key files.

Section 1.2
SNMP MIB Support

Section 1.2.1
Standard MIBs

Table: Standard MIBs

Standard	MIB Name	Title
RFC 2578	SNMPv2-SMI	Structure of Management Information Version 2
RFC 2579	SNMPv2-TC	Textual Convention s for SMIv2
RFC 2580	SNMPv2-CONF	Conformance Statements for SMIv2
	IANAifType	Enumerated Values of The ifType Object Defined ifTable defined in IF-MIB
RFC 1907	SNMPv2-MIB	Management Information Base for SNMPv2
RFC 2011	IP-MIB	SNMPv2 Mnagement Information Base for Internet Protocol using SMIv2

Standard	MIB Name	Title
RFC 2012	TCP-MIB	SNMPv2 Management Information Base for the Transmission Control Protocol using SMIv2
RFC 2013	UDP-MIB	Management Information Base for the UDP using SMIv2
RFC 1659	RS-232-MIB	Definitions of Managed Objects for RS-232-like Hardware Devices
RFC 2863	IF-MIB	The Interface Group MIB
RFC 2819	RMON-MIB	Remote Network Monitoring management Information Base
RFC 4188	BRIDGE-MIB	Definitions of Managed Objects for Bridges
RFC 4318	STP-MIB	Definitions of Managed Objects for Bridges with Rapid Spanning Tree Protocol
RFC 3411	SNMP-FRAMEWORK-MIB	An Architecture for Describing Simple Network Management Protocol (SNMP) Management Framework
RFC 3414	SNMP-USER-BASED-SM-MIB	User-based Security Model (USM) for Version 3 of the Simple Network Management Protocol (SNMPv3)
RFC 3415	SNMP-VIEW-BASED-ACM-MIB	View-bsed Access Control Model (VACM) for the Simple Management Protocol (SNMP)
IEEE 802.3ad	IEEE8023-LAG-MIB	Management Information Base Module for Link Aggregation
IEEE 802.1AB-2005	LLDP-MIB	Management Information Base Module for LLDP Configuration, Statistics, Local System Data and Remote Systems Data Components
RFC 4363	Q-BRIDGE-MIB	Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering, and Virtual LAN Extensions

Section 1.2.2
Siemens Proprietary MIBs

Table: TITLE

File Name	MIB Name	Description
ruggedcom.mib	RUGGEDCOM-MIB	RUGGEDCOM enterprise SMI
ruggedcomtraps.mib	RUGGEDCOM-TRAPS-MIB	RUGGEDCOM traps definition
rcsysinfo.mib	RUGGEDCOM-SYS-INFO-MIB	General system information about RUGGEDCOM device
rcDot11.mib	RUGGEDCOM-DOT11-MIB	Managemet for wireless interface on RUGGEDCOM device
rcPoe.mib	RUGGEDCOM-POE-MIB	Management for POE ports on RUGGEDCOM device
rcSerial.mib	RUGGEDCOM-SERIAL-MIB	Managemet for seral ports on RUGGEDCOM device

File Name	MIB Name	Description
rcRstp.mib	RUGGEDCOM-STP-MIB	Management for STP protocol

Section 1.2.3

Siemens Supported Agent Capabilities MIBs

SNMPv2-MIB defines branch mib-2/system and sysORTable. This table is described as:

> The (conceptual) table listing the capabilities of the local SNMPv2 entity acting in an agent role with respect to various MIB modules.

When this table is retrieved by an NMS, all Agent Capabilities supported by devices (sysORID object) and their descriptions (sysORDescr) are retrieved.

These Agent Capabilities and descriptions are defined in Siemens Agent Capabilities MIBs. Each supported MIB is accompanied with Agent Capabilities MIBs. Agent Capabilites list supported MIBs, supported groups of objects in them, and possible variations for particular objects.

Table: TITLE

File Name	MIB Name	Supported MIB
rcsnmpv2AC.mib	RC-SNMPv2-MIB-AC	SNMPv2-MIB
rcudpmibAC.mib	RC-UDP-MIB-AC	UDP-MIB
rctcpmibAC.mib	RC-TCP-MIB-AC	TCP-MIB
rcSnmpUserBasedSmMibAC.mib	RC-SNMP-USER-BASED-SM-MIB-AC	SNMP-USER-BASED-SM-MIB-AC
rcSnmpViewBasedAcmMibAC.mib	RC-SNMP-VIEW-BASED-ACM-MIB-AC	SNMP-VIEW-BASED-ACM-MIB-AC
rcifmibAC.mib	RC-IF-MIB-AC	IF-MIB
rcbridgemibAC.mib	RC-BRIDGE-MIB-AC	BRIDGE-MIB
rcrmonmibAC.mib	RC-RMON-MIB-AC	RMON-MIB
rcqbridgemibAC.mib	RC-Q-BRIDGE-MIB-AC	Q-BRIDGE-MIB
rcipmibAC.mib	RC-IP-MIB-AC	IP-MIB
rclldpmibAC.mib	RC-LLDP-MIB-AC	LLDP-MIB
rclagmibAC.mib	RC-LAG-MIB-AC	IEEE8023-LAG-MIB
rcrstpmibAC.mib	RC-STP-MIB-AC	STP-MIB
rcrcdot11AC.mib	RC-RUGGEDCOM-DOT11-MIB-AC	RUGGEDCOM-DOT11- MIB
rcrcpoeAC.mib	RC-RUGGEDCOM-POE-MIB-AC	RUGGEDCOM-POE-MIB
rcrcrstpmibAC.mib	RC-RUGGEDCOM-STP-AC-MIB	RUGGEDCOM-STP-MIB
rcrcsysinfomibAC.mib	RC-RUGGEDCOM-SYS-INFO-MIB-AC	RUGGEDCOM-SYS-INFO-MIB
rcrctrapsmibAC.mib	RC-RUGGEDCOM-TRAPS-MIB-AC	RUGGEDCOM-TRAPS-MIB
rcrs232mibAC.mib	RUGGEDCOM-RS-232-MIB-AC	RS-232-MIB
rcserialmibAC.mib	RC-RUGGEDCOM-SERIAL-MIB-AC	RUGGEDCOM-SERIAL-MIB

The following is an example from an RS416 device that describes the way to find objects and variations for supported MIBs:

NOTE
RS416 running ROS-CF52 Main v supports “ruggedcomRcTrapsAC01”.

RC-RUGGEDCOM-TRAPS-MIB-AC defines “ruggedcomRcTrapsAC01” support for the following groups from RUGGEDCOM-TRAPS-MIB:

```
ruggedcomGenericTrapGroup,
ruggedcomPowerSupplyGroup,
ruggedcomNotificationsGroup,
ruggedcomSecurityGroup

RUGGEDCOM-TRAPS-MIB lists following objects in ruggedcomGenericTrapGroup:
ruggedcomGenericTrapGroup OBJECT-GROUP
  OBJECTS   {
          genericTrapSeverity,
          genericTrapDescription
        }
```

Query result – walking through sysORTable from RS416:

```
1: sysORID.1 (OBJECT IDENTIFIER) ruggedcomSnmpv2AC
2: sysORID.2 (OBJECT IDENTIFIER) ruggedcomSnmpFrameworkAC
3: sysORID.3 (OBJECT IDENTIFIER) ruggedcomSnmpUserBasedSmAC
4: sysORID.4 (OBJECT IDENTIFIER) ruggedcomSnmpViewBasedAcmAC
5: sysORID.5 (OBJECT IDENTIFIER) ruggedcomIfAC
6: sysORID.6 (OBJECT IDENTIFIER) ruggedcomTcpAC
7: sysORID.7 (OBJECT IDENTIFIER) ruggedcomUdpAC
8: sysORID.8 (OBJECT IDENTIFIER) ruggedcomIpAC
9: sysORID.9 (OBJECT IDENTIFIER) ruggedcomRcIpAC
10: sysORID.10 (OBJECT IDENTIFIER) ruggedcomRcTrapsAC01
11: sysORID.11 (OBJECT IDENTIFIER) ruggedcomRcSysinfoAC01
12: sysORID.12 (OBJECT IDENTIFIER) ruggedcomBridgeAC
13: sysORID.13 (OBJECT IDENTIFIER) ruggedcomRstpAC
14: sysORID.14 (OBJECT IDENTIFIER) ruggedcomRcStpAC
15: sysORID.15 (OBJECT IDENTIFIER) ruggedcomLldpAC
16: sysORID.16 (OBJECT IDENTIFIER) ruggedcomRmonAC
17: sysORID.17 (OBJECT IDENTIFIER) ruggedcomqBridgeAC
18: sysORID.18 (OBJECT IDENTIFIER) ruggedcomLagAC
19: sysORID.19 (OBJECT IDENTIFIER) ruggedcomRs232AC
20: sysORID.20 (OBJECT IDENTIFIER) ruggedcomRcSerialAC
21: sysORDescr.1 (DisplayString) SNMPv2-MIB Agent Capabilities.
[53.4E.4D.50.76.32.2D.4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.
69.65.73.2E (hex)]
22: sysORDescr.2 (DisplayString) SNMP-FRAMEWORK-MIB Agent Capabilities.
[53.4E.4D.50.2D.46.52.41.4D.45.57.4F.52.4B.2D.4D.49.42.20.41.67.65.6E.74.20.43.
61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
23: sysORDescr.3 (DisplayString) SNMP-USER-BASED-SM-MIB Agent Capabilities.
[53.4E.4D.50.2D.55.53.45.52.2D.42.41.53.45.44.2D.53.4D.2D.4D.49.42.20.41.67.65.
6E.74.20.43.
61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
24: sysORDescr.4 (DisplayString) SNMP-VIEW-BASED-ACM-MIB Agent Capabilities.
[53.4E.4D.50.2D.56.49.45.57.2D.42.41.53.45.44.2D.41.43.4D.2D.4D.49.42.20.41.67.
65.6E.74.20.
43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
25: sysORDescr.5 (DisplayString) IF-MIB Agent Capabilities. [49.46.2D.4D.49.42.20.
41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
26: sysORDescr.6 (DisplayString) TCP-MIB Agent Capabilities. [54.43.50.2D.4D.49.
42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
27: sysORDescr.7 (DisplayString) UDP-MIB Agent Capabilities. [55.44.50.2D.4D.49.
42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]28:
sysORDescr.8 (DisplayString) IP-MIB Agent Capabilities. [49.50.2D.4D.49.42.20.41.
```

```
67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
29: sysORDescr.9 (DisplayString) RUGGEDCOM-IP-MIB Agent Capabilities. [52.55.
47.47.45.44.43.4F.4D.2D.49.50.2D.4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.
69.6C.69.74.69.65.73.2E (hex)]
30: sysORDescr.10 (DisplayString) RUGGEDCOM-TRAPS-MIB Agent Capabilities 01.
[52.55.47.47.45.44.43.4F.4D.2D.54.52.41.50.53.2D.4D.49.42.20.41.67.65.6E.74.20.
43.61.70.61.62.69.6C.69.74.69.65.73.20.30.31.2E (hex)]
31: sysORDescr.11 (DisplayString) RUGGEDCOM-SYS-INFO-MIB Agent Capabilities
01. [52.55.47.47.45.44.43.4F.4D.2D.53.59.53.2D.49.4E.46.4F.2D.4D.49.42.20.41.
67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.20.30.31.2E (hex)]
32: sysORDescr.12 (DisplayString) BRIDGE-MIB Agent Capabilities. [42.52.49.44.
47.45.2D.4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.
2E (hex)]
33: sysORDescr.13 (DisplayString) STP-MIB Agent Capabilities. [52.53.54.50.2D.
4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
34: sysORDescr.14 (DisplayString) RUGGEDCOM-STP-MIB Agent Capabilities. [52.
55.47.47.45.44.43.4F.4D.2D.53.54.50.2D.4D.49.42.20.41.67.65.6E.74.20.43.61.70.
61.62.69.6C.69.74.69.65.73.2E (hex)]
35: sysORDescr.15 (DisplayString) LLDP-MIB Agent Capabilities. [4C.4C.44.50.2D.
4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
36: sysORDescr.16 (DisplayString) RMON-MIB Agent Capabilities. [52.4D.4F.4E.2D.
4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
37: sysORDescr.17 (DisplayString) Q-BRIDGE-MIB Agent Capabilities. [51.2D.42.
52.49.44.47.45.2D.4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.
65.73.2E (hex)]
38: sysORDescr.18 (DisplayString) IEEE8023-LAG-MIB Agent Capabilities. Note
that this MIB is not implemented per compliance statement the IEEE8023-LAG-MIB
because of specific implemetation of Link Aggregation. [49.45.45.45.38.30.32.33.
2D.4C.41.47.2D.4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.
65.73.2E.20.4E.6F.74.65.20.74.68.61.74.20.74.68.69.73.20.4D.49.42.20.69.73.20.
6E.6F.74.20.69.6D.70.6C.65.6D.65.6E.74.65.64.20.70.65.72.20.63.6F.6D.70.6C.
69.61.6E.63.65.20.73.74.61.74.65.6D.65.6E.74.20.74.68.65.20.49.45.45.45.38.30.
32.33.2D.4C.41.47.2D.4D.49.42.20.62.65.63.61.75.73.65.20.6F.66.20.73.70.65.
63.69.66.69.63.20.69.6D.70.6C.65.6D.65.74.61.74.69.6F.6E.20.6F.66.20.4C.69.
E.6B.20.41.67.67.72.65.67.61.74.69.6F.6E.2E (hex)]
39: sysORDescr.19 (DisplayString) RS-232-MIB Agent Capabilities. [52.53.2D.32.
33.32.2D.4D.49.42.20.41.67.65.6E.74.20.43.61.70.61.62.69.6C.69.74.69.65.73.
2E (hex)]
40: sysORDescr.20 (DisplayString) RUGGEDCOM-SERIAL-MIB Agent Capabilities.
[52.55.47.47.45.44.43.4F.4D.2D.53.45.52.49.41.4C.2D.4D.49.42.20.41.67.65.6E.
74.20.43.61.70.61.62.69.6C.69.74.69.65.73.2E (hex)]
```

Notice the sysORID.10 object value. The sysORTable will describe precisely which MIB and which parts of the MIB are supported by the device.

Section 1.3

SNMP Trap Summary

The switch generates the following standard traps:

- from IF-MIB: linkDown, linkUp
- from SNMPv2-MIB: authenticationFailure coldStart
- from BRIDGE-MIB: newRoot, topologyChage
- from RMON-MIB: risingAlarm, fallingAlarm
- from LLDP-MIB: lldpRemoteTablesChange

The switch also generates several proprietary traps. These traps are described in the RC-TRAPS-MIB.

Table: Proprietary Traps

Trap	Source MIB
genericTrap	RC-TRAPS-MIB
powerSupplyTrap	
swUpgradeTrap	
cfgChangeTrap	
weakPasswordTrap	
defaultKeysTrap (For SSL keys only)	
bootVersionMismatchTrap	
rcRstpNewTpology	RUGGEDCOM-STP-MIB

Generic traps carry information about event in severity and description objects. They are sent at the time that an alarm is generated for the device. The following are examples of RUGGEDCOM Generic Traps, along with the severity of each one in brackets:

- heap error (alert)
- NTP server failure (notification)
- real time clock failure (error)
- failed password (warning)
- MAC address not learned by switch fabric (warning)
- BootP client: TFTP transfer failure (error)
- received looped back BPDU (error)
- received two consecutive confusing BPDUs on port, forcing down (error)
- GVRP failed to learn – too many VLANs (warning)

The information about generic traps can be retrieved using CLI command **`alarms`**.

The switch generates the following traps on specific events:

- from RUGGEDCOM-STP-MIB: rcRstpNewTopology – generated after topology becomes stable after a topology change occurs on a switch port.
- from RUGGEDCOM-POE-MIB: rcPoeOverheat and rcPoeOverload – generated by Power over Ethernet (PoE) overheat and overload conditions, respectively. These traps are only generated by RS900GP devices.

Section 1.4

Available Services by Port

The following table lists the services available by the device, including the following information:

- **Services**

  The service supported by the device
- **Port Number**

  The port number associated with the service
- **Port Open**

The port state, whether it is always open and cannot be closed, or open only, but can be configured

NOTE
In certain cases, the service might be disabled, but the port can stil be open (e.g. TFTP)

- **Port Default**

  The default state of the port (i.e. open or closed)

- **Access Authorized**

  Denotes whether the ports/services are authenticated during access

Services	Port Number	Port Open	Port Default	Access Authorized
Telnet	TCP/23	Open (configurable)	Closed	Yes
HTTP	TCP/80	Open, redirects to 443	Open	—
HTTPS	TCP/443	Open	Open	Yes
RSH	TCP/512	Open (configurable)	Closed	Yes
TFTP	UDP/69	Open	Open (service disabled)	No
SFTP	TCP/22	Open	Open	Yes
SNMP	UDP/161	Open	Open	Yes
SNTP	UDP/123	Open - Always might acts as server	Open	No
SSH	TCP/22	Open	Open	Yes
ICMP	—	Open	Open	No
TACACS+	TCP/49 (configurable)	Open (configurable)	Closed	Yes
RADIUS	UDP/1812 to send (configurable), opens random port to listen to	Open (configurable)	Closed	Yes
Remote Syslog	UDP/514 (configurable)	Open (configurable)	Closed	No
DNP over RawSocket	TCP/21001 to TCP/21016	Open (configurable)	Closed	No
DNPv3	UDP/20000 TCP/20000	UDP Open; TCP open after configured first time - can not be closed	UDP Open; TCP Closed	No
RawSocket/Telnet COM	UDP/50001 to UDP/50016 TCP/50001 to TCP/50016	Open (configurable)	Closed	No
TIN	UDP/51000 TCP/51000	UDP Open; TCP open after configured first time - can not be closed	UDP Open; TCP Closed	No

Services	Port Number	Port Open	Port Default	Access Authorized
WIN	UDP/52000 TCP/52000	UDP Open; TCP open after configured first time - can not be closed	UDP Open; TCP Closed	No
MICROLOK	UDP/60000	UDP Open; TCP open after configured first time - can not be closed	UDP Open; TCP Closed	No
MirroredBits	UDP/61001 to UDP/61016	Open (configurable)	Closed	No
TCP Modbus (Server) (including Management access)	TCP/502	Open	Open	No
TCP Modbus (Switch) (Management access)	TCP/502	Open (configurable)	Closed	No
DHCP, DHCP Agent	UDP/67 sending msg if enabled - if received, always come to CPU, dropped if service not configured	Open	Open	No
DHCP Server (WLAN)	UDP/67 for listening UDP/68 for responding	Open	Open	No
RCDP	—	Open (configurable)	Closed	Yes

Section 1.5

ModBus Management Support and Memory Map

ModBus management support in RUGGEDCOM devices provides a simple interface for retrieving basic status information. ModBus support simplifies the job of SCADA (Supervisory Control And Data Acquisition) system integrators by providing familiar protocol for the retrieval of RUGGEDCOM device information. ModBus provides mostly read-only status information, but there are also a few writable registers for operator commands.

The ModBus protocol PDU (Protocol Data Unit) format is as follows:

Function Code	Data

RUGGEDCOM devices support the following ModBus function codes for device management through ModBus:

1. Read Input Registers or Read Holding Registers – 0x04 or 0x03, for which the Modbus PDU looks like:

   Request

Function code	1 Byte	0x04(0x03)
Starting Address	2 Bytes	0x0000 to 0xFFFF
Number of Input Registers	2 Bytes	0x0001 to 0x007D

   Response

Function code	1 Byte	0x04(0x03)
Byte Count	1 Byte	2 x *N**

Input Registers	*N**X2 Bytes	

**N* = the number of Input Registers

2. Write Multiple Registers – 0x10:

   Request

Function code	1 Byte	0x10
Starting Address	2 Bytes	0x0000 to 0xFFFF
Number of Registers	2 Bytes	0x0001 to 0x0079
Byte Count	1 Byte	2 x *N**
Registers Value	*N** x 2 Bytes	Value of the register

**N* = the number of Input Registers

Response

Function code	1 Byte	0x10
Starting Address	2 Bytes	0x0000 to 0xFFFF
Number of Registers	2 Bytes	1 to 121 (0x79)

Note that as RUGGEDCOM devices have a variable number of ports, not all registers and bits apply to all products.

Registers that are not applicable to a particular product return a zero value. For example, registers referring to serial ports are not applicable to RUGGEDCOM products.

Section 1.5.1

Modbus Memory Map

Address	#Registers	Description (Reference Table in UI)	R/W	Format
PRODUCT INFO (table Name: ProductInfo)				
0000	16	Product Identification	R	Text
0010	32	Firmware Identification	R	Text
0040	1	Number of Ethernet Ports	R	Uint16
0041	1	Number of Serial Ports	R	Uint16
0042	1	Number of Alarms	R	Uint16
0043	1	Power Supply Status	R	PSStatusCmd
0044	1	FailSafe Relay Status	R	TruthValue
0045	1	ErrorAlarm Status	R	TruthValue
PRODUCT WRITE REGISTERS (table Name: various tables)				
0080	1	Clear Alarms	W	Cmd

Address	#Registers	Description (Reference Table in UI)	R/W	Format
0081	2	Reset Ethernet Ports	W	PortCmd
0083	2	Clear Ethernet Statistics	W	PortCmd
0085	2	Reset Serial Ports	W	PortCmd
0087	2	Clear Serial Port Statistics	W	PortCmd
ALARMS (table Name: alarms)				
0100	64	Alarm 1	R	Alarm
0140	64	Alarm 2	R	Alarm
0180	64	Alarm 3	R	Alarm
01C0	64	Alarm 4	R	Alarm
0200	64	Alarm 5	R	Alarm
0240	64	Alarm 6	R	Alarm
0280	64	Alarm 7	R	Alarm
02C0	64	Alarm 8	R	Alarm
ETHERNET PORT STATUS (table Name: ethPortStats)				
03FE	2	Port Link Status	R	PortCmd
ETHERNET STATISTICS (table Name: rmonStats)				
0400	2	Port 1 Statistics - Ethernet In Packets	R	Uint32
0402	2	Port 2 Statistics - Ethernet In Packets	R	Uint32
0404	2	Port 3 Statistics - Ethernet In Packets	R	Uint32
0406	2	Port 4 Statistics - Ethernet In Packets	R	Uint32
0408	2	Port 5 Statistics - Ethernet In Packets	R	Uint32
040A	2	Port 6 Statistics - Ethernet In Packets	R	Uint32
040C	2	Port 7 Statistics - Ethernet In Packets	R	Uint32
040E	2	Port 8 Statistics - Ethernet In Packets	R	Uint32
0410	2	Port 9 Statistics - Ethernet In Packets	R	Uint32
0412	2	Port 10 Statistics - Ethernet In Packets	R	Uint32

Address	#Registers	Description (Reference Table in UI)	R/W	Format
0414	2	Port 11 Statistics - Ethernet In Packets	R	Uint32
0416	2	Port 12 Statistics - Ethernet In Packets	R	Uint32
0418	2	Port 13 Statistics - Ethernet In Packets	R	Uint32
041A	2	Port 14 Statistics - Ethernet In Packets	R	Uint32
041C	2	Port 15 Statistics - Ethernet In Packets	R	Uint32
041E	2	Port 16 Statistics - Ethernet In Packets	R	Uint32
0420	2	Port 17 Statistics - Ethernet In Packets	R	Uint32
0422	2	Port 18 Statistics - Ethernet In Packets	R	Uint32
0424	2	Port 19 Statistics - Ethernet In Packets	R	Uint32
0426	2	Port 20 Statistics - Ethernet In Packets	R	Uint32
0440	2	Port 1 Statistics - Ethernet Out Packets	R	Uint32
0442	2	Port 2 Statistics - Ethernet Out Packets	R	Uint32
0444	2	Port 3 Statistics - Ethernet Out Packets	R	Uint32
0446	2	Port 4 Statistics - Ethernet Out Packets	R	Uint32
0448	2	Port 5 Statistics - Ethernet Out Packets	R	Uint32
044A	2	Port 6 Statistics - Ethernet Out Packets	R	Uint32
044C	2	Port 7 Statistics - Ethernet Out Packets	R	Uint32
044E	2	Port 8 Statistics - Ethernet Out Packets	R	Uint32
0450	2	Port 9 Statistics - Ethernet Out Packets	R	Uint32
0452	2	Port 10 Statistics - Ethernet Out Packets	R	Uint32
0454	2	Port 11 Statistics - Ethernet Out Packets	R	Uint32
0456	2	Port 12 Statistics - Ethernet Out Packets	R	Uint32

Address	#Registers	Description (Reference Table in UI)	R/W	Format
0458	2	Port 13 Statistics - Ethernet Out Packets	R	Uint32
045A	2	Port 14 Statistics - Ethernet Out Packets	R	Uint32
045C	2	Port 15 Statistics - Ethernet Out Packets	R	Uint32
045E	2	Port 16 Statistics - Ethernet Out Packets	R	Uint32
0460	2	Port 17 Statistics - Ethernet Out Packets	R	Uint32
0462	2	Port 18 Statistics - Ethernet Out Packets	R	Uint32
0464	2	Port 19 Statistics - Ethernet Out Packets	R	Uint32
0466	2	Port 20 Statistics - Ethernet Out Packets	R	Uint32
0480	2	Port 1 Statistics - Ethernet In Octets	R	Uint32
0482	2	Port 2 Statistics - Ethernet In Octets	R	Uint32
0484	2	Port 3 Statistics - Ethernet In Octets	R	Uint32
0486	2	Port 4 Statistics - Ethernet In Octets	R	Uint32
0488	2	Port 5 Statistics - Ethernet In Octets	R	Uint32
048A	2	Port 6 Statistics - Ethernet In Octets	R	Uint32
048C	2	Port 7 Statistics - Ethernet In Octets	R	Uint32
048E	2	Port 8 Statistics - Ethernet In Octets	R	Uint32
0490	2	Port 9 Statistics - Ethernet In Octets	R	Uint32
0492	2	Port 10 Statistics - Ethernet In Octets	R	Uint32
0494	2	Port 11 Statistics - Ethernet In Octets	R	Uint32
0496	2	Port 12 Statistics - Ethernet In Octets	R	Uint32
0498	2	Port 13 Statistics - Ethernet In Octets	R	Uint32
049A	2	Port 14 Statistics - Ethernet In Octets	R	Uint32

Address	#Registers	Description (Reference Table in UI)	R/W	Format
049C	2	Port 15 Statistics - Ethernet In Octets	R	Uint32
049E	2	Port 16 Statistics - Ethernet In Octets	R	Uint32
04A0	2	Port 17 Statistics - Ethernet In Octets	R	Uint32
04A2	2	Port 18 Statistics - Ethernet In Octets	R	Uint32
04A4	2	Port 19 Statistics - Ethernet In Octets	R	Uint32
04A6	2	Port 20 Statistics - Ethernet In Octets	R	Uint32
04C0	2	Port 1 Statistics - Ethernet Out Octets	R	Uint32
04C2	2	Port 2 Statistics - Ethernet Out Octets	R	Uint32
04C4	2	Port 3 Statistics - Ethernet Out Octets	R	Uint32
04C6	2	Port 4 Statistics - Ethernet Out Octets	R	Uint32
04C8	2	Port 5 Statistics - Ethernet Out Octets	R	Uint32
04CA	2	Port 6 Statistics - Ethernet Out Octets	R	Uint32
04CC	2	Port 7 Statistics - Ethernet Out Octets	R	Uint32
04CE	2	Port 8 Statistics - Ethernet Out Octets	R	Uint32
04D0	2	Port 9 Statistics - Ethernet Out Octets	R	Uint32
04D2	2	Port 10 Statistics - Ethernet Out Octets	R	Uint32
04D4	2	Port 11 Statistics - Ethernet Out Octets	R	Uint32
04D6	2	Port 12 Statistics - Ethernet Out Octets	R	Uint32
04D8	2	Port 13 Statistics - Ethernet Out Octets	R	Uint32
04DA	2	Port 14 Statistics - Ethernet Out Octets	R	Uint32
04DC	2	Port 15 Statistics - Ethernet Out Octets	R	Uint32
04DE	2	Port 16 Statistics - Ethernet Out Octets	R	Uint32

Address	#Registers	Description (Reference Table in UI)	R/W	Format
04E0	2	Port 17 Statistics - Ethernet Out Octets	R	Uint32
04E2	2	Port 18 Statistics - Ethernet Out Octets	R	Uint32
04E4	2	Port 19 Statistics - Ethernet Out Octets	R	Uint32
04E6	2	Port 20 Statistics - Ethernet Out Octets	R	Uint32
SERIAL STATISTICS (table Name: uartPortStatus)				
0600	2	Port 1 Statistics – Serial In characters	R	Uint32
0602	2	Port 2 Statistics – Serial In characters	R	Uint32
0604	2	Port 3 Statistics – Serial In characters	R	Uint32
0606	2	Port 4 Statistics – Serial In characters	R	Uint32
0640	2	Port 1 Statistics – Serial Out characters	R	Uint32
0642	2	Port 2 Statistics – Serial Out characters	R	Uint32
0644	2	Port 3 Statistics – Serial Out characters	R	Uint32
0646	2	Port 4 Statistics – Serial Out characters	R	Uint32
0680	2	Port 1 Statistics – Serial In Packets	R	Uint32
0682	2	Port 2 Statistics – Serial In Packets	R	Uint32
0684	2	Port 3 Statistics – Serial In Packets	R	Uint32
0686	2	Port 4 Statistics – Serial In Packets	R	Uint32
06C0	2	Port 1 Statistics – Serial Out Packets	R	Uint32
06C2	2	Port 2 Statistics – Serial Out Packets	R	Uint32
06C4	2	Port 3 Statistics – Serial Out Packets	R	Uint32
06C6	2	Port 4 Statistics – Serial Out Packets	R	Uint32

Section 1.5.1.1
Text

This format provides a simple ASCII representation of the information related to the product. ASCII characters' most significant byte of register comes first.

For example, consider a "Read Multiple Registers" request to read Product Identification from location 0x0000.

0x04	0x00	0x00	0x00	0x08

The response may look like:

0x04	0x10	0x53	0x59	0x53	0x54	0x45	0x4D	0x20	0x4E	0x41	0x4D	0x45
0x00	0x00	0x00	0x00	0x00								

In this example, starting from byte 3 until the end, the response presents an ASCII representation of the characters for the product identification, which reads as "SYSTEM NAME". The length of this field is smaller than eight registers, so the rest of the field is filled with zeros.

Section 1.5.1.2
Cmd

This format instructs the device to set the output to either 'true' or 'false'. The most significant byte comes first.

- FF 00 hex requests output to be True.
- 00 00 hex requests output to be False.
- Any value other than the suggested values does not affect the requested operation.

For example, consider a "Write Multiple Registers" request to clear alarms in the device.

0x10	0x00	0x80	0x00	0x01	2	0xFF	0x00

- FF 00 for register 00 80 clears the system alarms
- 00 00 does not clear any alarms

The response may look like:

0x10	0x00	0x80	0x00	0x01

Section 1.5.1.3
Uint16

This format describes a Standard Modbus 16-bit register.

Section 1.5.1.4
Uint32

This format describes Standard 2 Modbus 16-bit registers. The first register holds the most significant 16 bits of a 32 bit value. The second register holds the least significant 16 bits of a 32 bit value.

Section 1.5.1.5
PortCmd

This format describes a bit layout per port, where 1 indicates the requested action is true, and 0 indicates the requested action is false.

PortCmd provides a bit layout of a maximum of 32 ports; therefore, it uses two Modbus registers:

- The first Modbus register corresponds to ports 1 – 16.
- The second Modbus register corresponds to ports 17 – 32 for a particular action.

Bits that do not apply to a particular product are always set to zero.

A bit value of 1 indicates that the requested action is true. For example: the particular port is “up”.

A bit value of 0 indicates that the requested action is false. For example: the particular port is “down”.

Reading data using PortCmd:

For example, consider a Modbus Request to read multiple registers from location 0x03FE.

0x04	0x03	0xFE	0x00	0x02

The response depends on how many ports are available on the device. For example, if the maximum number of ports on a connected RUGGEDCOM device is 20, the response would look like the following:

0x04	0x04	0xF2	0x76	0x00	0x05

In this example, bytes 3 and 4 refer to register 1 at location 0X03FE, and represent the status of ports 1–16. Bytes 5 and 6 refer to register 2 at location 0x03FF, and represent the status of ports 17–32. In this example, the device only has 20 ports, so byte 6 contains the status for ports 17-20 starting from right to left. The rest of the bits in register 2 corresponding to the non-existing ports 21–31 are zero.

Performing write actions using PortCmd:

For example, consider a “Write Multiple Register” request to clear Ethernet port statistics:

0x10	0x00	0x83	0x00	0x01	2	0x55	0x76	0x00	0x50

A bit value of 1 is a command to clear Ethernet statistics on a corresponding port. A bit value of 0 is a command to “do nothing” on a corresponding port.

The response may look like:

0x10	0x00	0x81	0x00	0x02

Section 1.5.1.6
Alarm

This format is another form of text description. Alarm text corresponds to the alarm description from the table holding all of the alarms. Similar to the ‘Text’ format, this format returns ASCII representation of alarms. Note that alarms are stacked in the RUGGEDCOM device in the sequence of their occurrence. That is, the first alarm on the stack is Alarm 1, the next latched alarm in the device is Alarm 2, and so on. You can return the first eight alarms from the stack, if they exist. A zero value is returned if an alarm does not exist.

Section 1.5.1.7
PSStatusCmd

This format describes a bit layout for providing the status of available power supplies. Bits 0–4 of the lower byte of the register are used for this purpose.

Bits 0–1: Power Supply 1 Status.

Bits 2–3: Power supply 2 Status

The rest of the bits in the register do not provide any system status information.

Table: PSStatusCmd Bit Values

Bit Value	Description
01	Power Supply not present (01 = 1).
10	Power Supply is functional (10 = 2).
11	Power Supply is not functional (11 = 3).

The values used for power supply status are derived from the RUGGEDCOM-specific SNMP MIB.

Read Power Supply Status from device using PSStatusCmd:

In this example, consider a Modbus Request to read multiple registers from location 0x0043.

0x04	0x00	0x43	0x00	0x01

Response may look like:

0x04	0x02	0x00	0x0A

The lower byte of the register displays the power supplies' status. In this example, both power supplies in the unit are functional.

Section 1.5.1.8
TruthValue

This format represents a true or false status in the device:

- 1 – indicates the corresponding status for the device to be true.
- 2 – indicates the corresponding status for the device to be false.

Read FailSafe Relay status from device using TruthValue:

For example, consider a Modbus Request to read multiple registers from location 0x0044.

0x04	0x00	0x44	0x00	0x01

Response may look like:

0x04	0x02	0x00	0x01

The register's lower byte shows the FailSafe Relay status. In this example, the failsafe relay is energized.

Read ErrorAlarm status from device using TruthValue:

For example, consider a Modbus Request to read multiple registers from location 0x0045.

0x04	0x00	0x45	0x00	0x01

Response may look like:

0x04	0x02	0x00	0x01

The register's lower byte shows the alarm status. In this example, there is no active ERROR, ALERT or CRITICAL alarm in the device.

Section 1.6

Command Line Listing

The following commands are available at the command line of ROS-based devices:

alarms	Displays list of available alarms. Usage: alarms [all] all - display all alarm instances (default empty) - display one instance of each alarm type.
arp	Displays the IP to MAC address resolution table.
clearalarms	Clears all alarms
clearethstats	Clears Ethernet statistics for one or more port(s) clearethstats ports|'all' 'ports' - comma separated port numbers (e.g. '1,3-5,7') 'all' - all ports
clearlogs	Clears the system and crash logs
clrcblstats	Clears Cable Diagnostics statistics for one or more port(s). clrcblstats ports|'all' ports - comma separated port numbers (e.g. '1,3-5,7') 'all' - all ports
clearstpstats	Clear all spanning tree statistics.
cls	Clears the screen
dir	Prints file directory listing
exit	Terminate this command line session
factory	Enables factory mode, which includes several factory-level commands used for testing and troubleshooting. Only available to admin users. **CAUTION!** *Misuse of the factory commands may corrupt the operational state of device and/or may permanently damage the ability to recover the device without manufacturer intervention.*
flashfiles	A set of diagnostic commands to display information about the Flash filesystem and to defragment Flash memory. Usage: flashfiles Displays Flash memory statistics and Flash memory file system contents. Usage: flashfiles info [filename] Displays information about the specified file in the Flash filesystem. Usage: flashfiles defrag Defragments files in the Flash filesystem.
flashleds	Flashes the unit LED indicators for the specified number of seconds.

	Usage: flashleds timeout timeout: the number of seconds to flash the unit LED indicators. To stop flashing the LEDs, set timeout to 0 (zero).
help	help [command name] [command name] - Name of command for which to get help. If no command is specified, a list of all available commands is displayed along with a brief description of each one.
ipconfig	Displays IP configuration
loaddflts	Load Factory Default Configuration.
login	Login to the shell i.e. set the access level
logout	Logout of the shell
ping	Usage: ping {dest} [count] [timeout] dest Target IP address. count Number of echo requests to send; default is 4. timeout Timeout in milliseconds to wait for each reply; range is 2-5000, default is 300 milliseconds.
purgemac	Purge the MAC Address Table.
reset	Perform a 'hard' reset of the switch
resetport	Reset one or more Ethernet ports which may be useful for forcing re-negotiation of speed and duplex or in situations where the link partner has latched into an inappropriate state. RESETPORT ports|'all' 'ports' - comma separated port numbers (e.g. '1,3-5,7') 'all' - all ports will be reset
rmon	Displays names of RMON alarm eligible objects
route	Displays gateway configuration
sql	The SQL command provides an 'sql like' interface for manipulating all system configuration and status parameters. Entering 'SQL HELP command-name' displays detailed help for a specific command. Commands, clauses, table, and column names are all case insensitive. DEFAULT Sets all records in a table(s) to factory defaults. DELETE Allows for records to be deleted from a table. HELP Provides help for any SQL command or clause. INFO Displays a variety of information about the tables in the database INSERT Enables new records to be inserted into a table. SAVE Saves the database to non-volatile memory storage. SELECT Queries the database and displays selected records. UPDATE Enables existing records in a table to be updated.
sslkeygen	Usage: sslkeygen Generates a new SSL certificate in `ssl.crt` Begins background generation of the credential file `ssl.crt`. The system log will indicate the beginning and successful completion of the process. Generation of `ssl.crt` may take several minutes.
sshkeygen (Controlled Version Only)	Usage: sshkeygen Generates new SSH keys in `ssh.keys` Begins background generation of the credential file `ssh.keys`.

	The system log will indicate the beginning and successful completion of the process. Generation of `ssh.keys` may take several minutes.
telnet	Usage: telnet dest dest: Server's IP address. **NOTE** *<Ctrl-C> closes telnet session*
tftp	Usage: tftp server cmd fsource fdest server: Remote TFTP server's IP address cmd: put (upload) or get (download) fsource: Source filename dest: Destination filename **NOTE** *<Ctrl-C> stops a tftp transfer.*
trace	Starts event tracing. Run "trace ?" for more help.
type	Displays the contents of a text file. Enter 'dir' for a directory listing of files. type filename
version	Prints software versions.
wlan pt	The WLAN passthrough command is a portal to access diagnostics shell of the WLAN interface. **CAUTION!** *Execution of WLAN passthrough command affects the normal operation of WLAN interface and should only be used under the supervision of Siemens personnel.*
xmodem	xmodem direction filename direction: send - send file to client receive - receive file from client filename: Enter 'dir' for list of all filenames

Section 1.7

Using the CLI Shell

ROS Command Line Interface (CLI) support enables:

- Execution of commands from a CLI shell.
- Remote execution of commands using RSH or SSH.
- Switching between the CLI shell and the menu system.

NOTE
Different commands may be available to users at different login session security levels (guest, operator or administrator).

The ROS CLI shell may be accessed from a terminal session to the device. A terminal session may be established in one of three ways:

- Direct cable, via RS-232.
- Remote via RSH.
- Remote via SSH.

When a terminal session is first established to the ROS device, the user interface presented will be the full-screen menu interface. Please refer to Section 2.1, “The ROS User Interface” for more detail on the menu interface.

The Command Line Interface (CLI) shell may be accessed from any menu by pressing <Ctrl-S>. Any menu operation in progress, such as changing a configuration parameter, will be terminated. You may return to the menu system by pressing <Ctrl-S> again or by entering “exit<CR>” at the shell prompt.

This section describes a selection of the most useful commands in detail. For a complete list of available commands, please refer to Section 1.6, “Command Line Listing”.

Section 1.7.1
Summary Of CLI Commands Available in ROS

Type “help” and press **Enter** to see the list of commands available at the current session access level. For more information on the ROS CLI commands, see Section 1.6, “Command Line Listing”.

Section 1.7.2
Obtaining Help For A Command

Help related to the usage of a particular command may be obtained by entering “help command name <CR>” at the shell prompt.

```
>help type
Displays the contents of a text file.
Enter 'dir' for a directory listing of files.

TYPE filename
```

Figure 1: Displaying Help For A Command

Section 1.7.3
Viewing Files

RUGGEDCOM devices maintain a number of volatile and non-volatile files. These files can aid in the resolution of problems and serve as a useful gauge of the device’s health.

Section 1.7.3.1
Listing Files

Enter “dir<CR>” to obtain a complete list of files and a description of each.

NOTE
Each file has associated attributes, as described under the Attr column in “dir” command. Files marked “R” are readable, i.e. may be uploaded by the user. Files marked “W” are writable, i.e. may be modified (downloaded) by the user. Files marked “B” are binary files, i.e. may be upgraded by the user.

The most useful files include config.csv, crashlog.txt and syslog.txt. These files may be viewed by using the “type” command, specifying the desired filename.

```
>dir
Directory of RuggedSwitch
--------------------------------------------------------------------------------
Free files:   18 of 32
Free handles: 31 of 32
Free blocks:  2048 of 2048
Block size:   4096
--------------------------------------------------------------------------------
Filename             Size Hdls Blks Attr Description
--------------------------------------------------------------------------------
dir.txt                 0    1    1 R   Listing of files and attributes.
boot.bin          1049514    0    0 RWB Boot firmware
main.bin          1169341    0    0 RWB Operating system firmware
fpga.xsvf           55784    0    0 RWB FPGA programming file binary file
fpga2288.xsvf     2656569    0    0 RWB FPGA2288 programming file binary
file
factory.txt           898    0    0 RW  Factory data parameters
config.csv          21506    0    0 RW  System settings
config.bak          21506    0    0 RW  System settings backup
crashlog.txt            0    0    0 RW  Log of debilitating system events
banner.txt              0    0    0 RW  User defined free-text banner
ssl.crt              1718    0    0  W  SSL Certificate
ssh.keys              404    0    0  W  SSH Keys
syslog.txt          16669    0    0 RW  Log of system events
cfgdiff.csv             0    0    0 R   Changed configuration settings.
--------------------------------------------------------------------------------
```

Figure 2: Displaying The Directory Of A ROSDevice

Section 1.7.3.2
Viewing and Clearing Log Files

The crashlog.txt and syslog.txt files contain historical information about events that have occurred.

The crashlog.txt file will contain debugging information related to problems that might have resulted in unplanned restarts of the device or which may effect the device operation. A file size of 0 bytes indicates that no untoward events have occurred.

The syslog.txt file contains a record of significant events including startups, configuration modifications, firmware upgrades and database re-initializations due to feature additions. Syslog.txt file will accumulate information until it fills, holding approximately 3 megabytes of characters.

The “clearlogs” command resets these logs. It is recommended to run “clearlogs” command after every firmware upgrade.

Section 1.7.4
Managing the Flash Filesystem

The *flashfiles* command is an interface to three utilities for obtaining information about and for managing the Flash filesystem maintained by ROS:

- Flash filesystem statistics display.
- Detailed information about a specific file.
- Flash filesystem defragmentation tool.

```
>help flashfiles
A set of diagnostic commands to display information about the Flash filesystem and to defragment flash
 memory.

flashfiles
   When no parameters are provided, statistics about the Flash memory and
   filesystem are printed.

flashfiles info [filename]
   Provides information about a specific file in the Flash filesystem.

flashfiles defrag
   Defragments files in the Flash filesystem.
```

Figure 3: Flashfiles command summary

Section 1.7.4.1
Flash Filesystem Memory Mapping

When the *flashfiles* command is invoked with no arguments, a listing is displayed of files currently in Flash memory, their locations, and the amount of memory they consume:

```
>flashfiles
--------------------------------------------------------------------------------
Filename             Base   Size  Sectors     Used
--------------------------------------------------------------------------------
boot.bin         00000000 110000    0-23   1049514
main.bin         00110000 120000   24-41   1169341
fpga.xsvf        00230000 010000   42-42     55784
fpga2288.xsvf    00240000 290000   43-83   2656569
syslog.txt       004D0000 2D0000   84-128    16925
ssh.keys         007A0000 010000  129-129      660
ssl.crt          007B0000 010000  130-130     1974
banner.txt       007C0000 010000  131-131      256
crashlog.txt     007D0000 010000  132-132      256
config.bak       007E0000 010000  133-133    21762
config.csv       007F6000 008000  137-140    21762
factory.txt      007FE000 002000  141-141     1154
--------------------------------------------------------------------------------
```

Figure 4: Flashfile Memory Mapping Summary

Section 1.7.4.2
Obtaining Information On a Particular File

When the *flashfiles* command is invoked with the key word, *info*, followed by the name of a file in memory as arguments, detailed information is displayed for the named file. For example:

```
>flashfiles info main.bin

Flash file information for main.bin:
Header version   : 4
Platform         : ROS-CF52
File name        : main.bin
Firmware version : v3.8.0.QA3
Build date       : Oct 23 2009 13:32
File length      : 2726770
Board IDs        :  ff   1   9   b   8   a  19  17
                     4   5  11  15  13  14   f  18
                     2   7   3  10   c   d  12  16
Header CRC       : 0827
Header CRC Calc  : 0827
Body CRC         : a270
Body CRC Calc    : a270
```

Figure 5: Obtaining Information About "main.bin"

Section 1.7.4.3
Defragmenting the Flash Filesystem

The flash memory defragmenter should be used in a case when not enough flash memory is left for a binary upgrade. Fragmentation may occur, for example, when switching between different firmware image versions that require different numbers of memory sectors. Sectors of available memory can become separated by ones allocated to files. It may be, for example, that the total available memory might be sufficient for a firmware update, but that memory may not be available in one contiguous region, as is required by ROS.

Note that Flash memory defragmentation is implemented as an automatically invoked function in bootloaders v2.15.1 and greater.

Section 1.7.5
Pinging a Remote Device

The “ping” command sends an ICMP echo request to a remotely connected device. For each reply received, the round trip time is displayed.

The command, “ping <IP address>”, will send a small number of pings to the device with this IP address and display the results. The ping command can be used to verify connectivity to the next connected device. It is a useful tool for testing commissioned links. This command also includes the ability to send a specific number of pings with a specified time for which to wait for a response.

The specification of a large number of pings and a short response time can “flood” a link, stressing it more than a usual ping sequence. The command “ping 192.168.0.1 500 2” can be used to issue 500 pings, each separated by two milliseconds to the next device. If the link used is of high quality, then no pings should be lost and the average round trip time should be small.

NOTE
The device to be pinged must support ICMP echo. Upon commencing the ping, an ARP request for the MAC address of the device is issued. If the device to be pinged is not on the same network as the device pinging the other device, the default gateway must be programmed.

Section 1.7.6
Tracing Events

The CLI trace command provides a means to trace the operation of various protocols supported by the device. Trace provides detailed information including STP packet decodes, IGMP activity and MAC address displays.

NOTE
Tracing has been designed to provide detailed information to expert users. Note that all tracing is disabled upon device startup.

In order to display the current trace settings and discover the systems that are being traced, enter the CLI command “trace ?”.

```
trace ?
Supported commands:
noclear          Starts the log without clearing it first
alloff           Disables all trace subsystems from tracing
allon            Enables all flags in all trace subsystems
stp              Traces STP operations
link             Displays switch fabric statistics
mac              Displays MAC Events
forward          Forwards trace messages to an IP:UDP address
igmp             Displays IGMP Snooping events
gvrp             Displays GVRP events
webs             Traces Web Server connections
dhcpra           Traces DHCP Relay Agent
802.1X           Traces 802.1X PAE
ip               Traces IP communications

Enter "trace command ?" for more information on a particular command.

STP  : Logging all conditions on port(s) 1-10
LINK : Logging is disabled
MAC  : Logging is disabled
FORW : IP: 0.0.0.0  UDP: 0 (OFF)
IGMP : Logging is disabled
GVRP : Logging is disabled
WEBS : Logging is disabled
DHCPRA : Logging is disabled
802.1X : Logging is disabled
IP   : Logging is disabled
```

Figure 6: Displaying Trace Settings

Section 1.7.6.1
Enabling Trace

Tracing can be enabled on a per subsystem basis. Obtain detailed information about individual subsystems by entering “trace subsystem_name ?<CR>”. Some subsystems offer a mechanism to enable tracing only on certain ports.

```
>trace stp ?
trace stp syntax:
  stp [-|+] [all] [verbose] [packets] [timers] [actions]
            [decodes] [ports[port_number|all]]
STP  : Logging is disabled

>trace stp all
STP  : Logging all conditions on port(s) 1-16

>trace link ?
trace link syntax
  link changes | stats | allon | alloff | statsonce
LINK : Logging is disabled

>trace link changes
LINK : changes
>
```

Figure 7: Enabling Trace

Section 1.7.6.2
Starting Trace

To start trace, enter “trace<CR>”. All historical trace messages may be displayed using “trace noclear<CR>”. Since this may include many messages, it may be more desirable to use the “trace clear<CR>” command instead. This command will automatically clear the trace buffer as it starts the trace.

```
>trace stp - all

STP  : Logging is disabled
>trace stp decodes

STP  : Logging decodes
>trace stp port 7

STP  : Logging decodes on port(s) 7

> trace link changes
LINK : changes

>trace

Log has been cleared
009.445 IGMP TX General Query, VLAN    1, gr. 000.000.000.000,
             to ports ALL VLAN PORTS
010.543 LINK Link 7 has risen.
000.550 STP TX port 7 RST BPDU: TCack 0 agg 1 lrn 0 fwd 0 role DP prop 1 TC 0
            root 32768/0adc001000 cst 38, brdg 32768/0adc005000, prt 128/7
            age 2.00, maxage 20, hello 2, fwddelay 15 V1Length 0
000.557 STP RX port 7 RST BPDU: TCack 0 agg 1 lrn 0 fwd 0 role DP prop 1 TC 0
            root 32768/0adc004000 cst 0, brdg 32768/0adc004000, prt 128/14
            age 0.00, maxage 20, hello 2, fwddelay 15 V1Length 0
```

Figure 8: Starting Trace

NOTE
The trace package includes the “forward” subsystem, a remote reporting facility intended to be used only under the direction of Siemens service personnel.

Section 1.7.7
Viewing DHCP Learned Information

The CLI command “ipconfig<CR>” will provide the current IP address, subnet mask and default gateway. This command provides the only way of determining these values when DHCP is used.

Section 1.7.8
Executing Commands Remotely Through RSH

The Remote Shell (RSH) facility can be used from a workstation to cause the product to act upon commands as if they were entered at the CLI prompt. The syntax of the RSH command is usually of the form:

```
rsh ipaddr -l auth_token command_string
```

where:

- `ipaddr` = The address or resolved name of the RUGGEDCOM device.
- `auth_token` = The authentication token, which for ROS rsh is the user name (guest, operator, or admin) and corresponding password separated by a comma. For example, to run a command as user - "admin" with password - "secret", the token would be: "admin,secret".
- `command_string` = The ROS shell command to execute.

The access level (corresponding to the user name) selected must support the given command.

Any output from the command will be returned to the workstation submitting the command. Commands that start interactive dialogs (such as trace) cannot be used.

Section 1.7.9

Resetting the Device

The CLI command “reset<CR>” can be used to reset the device.

2 Administration

The Administration menu covers the configuration of administrative parameters of both device and network (local services availability, security methods employed, system identification and functionality related to the IP network):

- IP Address, Subnet Mask and Gateway Address (static or dynamically obtainable)
- Management VLAN
- Management Connection Inactivity Timeout
- TFTP Server Permissions
- System Identification
- Passwords
- Time-Keeping
- SNMP Management
- Radius Server
- DHCP Relay Agent
- Remote Syslog

Section 2.1
The ROS User Interface

Section 2.1.1
Using the RS232 Port to Access the User Interface

Attach a terminal (or PC running terminal emulation software) to the RS232 port. The terminal should be configured for 8 bits, no parity operation at 57.6 Kbps. Hardware and software flow control must be disabled. Select a terminal type of VT100.

Once the terminal is connected, pressing any key on the keyboard will prompt for the user name and password to be entered.

CAUTION!
To prevent unauthorized access to the device, make sure to change the default username and password for each user level (i.e. operator, guest and admin) before commissioning the device. It is recommended that each username and password be unique and customized to the user to add an additional level of security.

The switch is shipped with a default administrator user name - “admin” - and password - “admin”. Once successfully logged in, the user will be presented with the main menu.

Section 2.1.2

The Structure of the User Interface

The user interface is organized as a series of menus with an escape to a command line interface (CLI) shell. Each menu screen presents the switch name (as provided by the System Identification parameter), Menu Title, Access Level, Alarms indicator, Sub-Menus and Command Bar.

Sub-menus are entered by selecting the desired menu with the arrow keys and pressing the enter key. Pressing the escape key returns you to the parent menu.

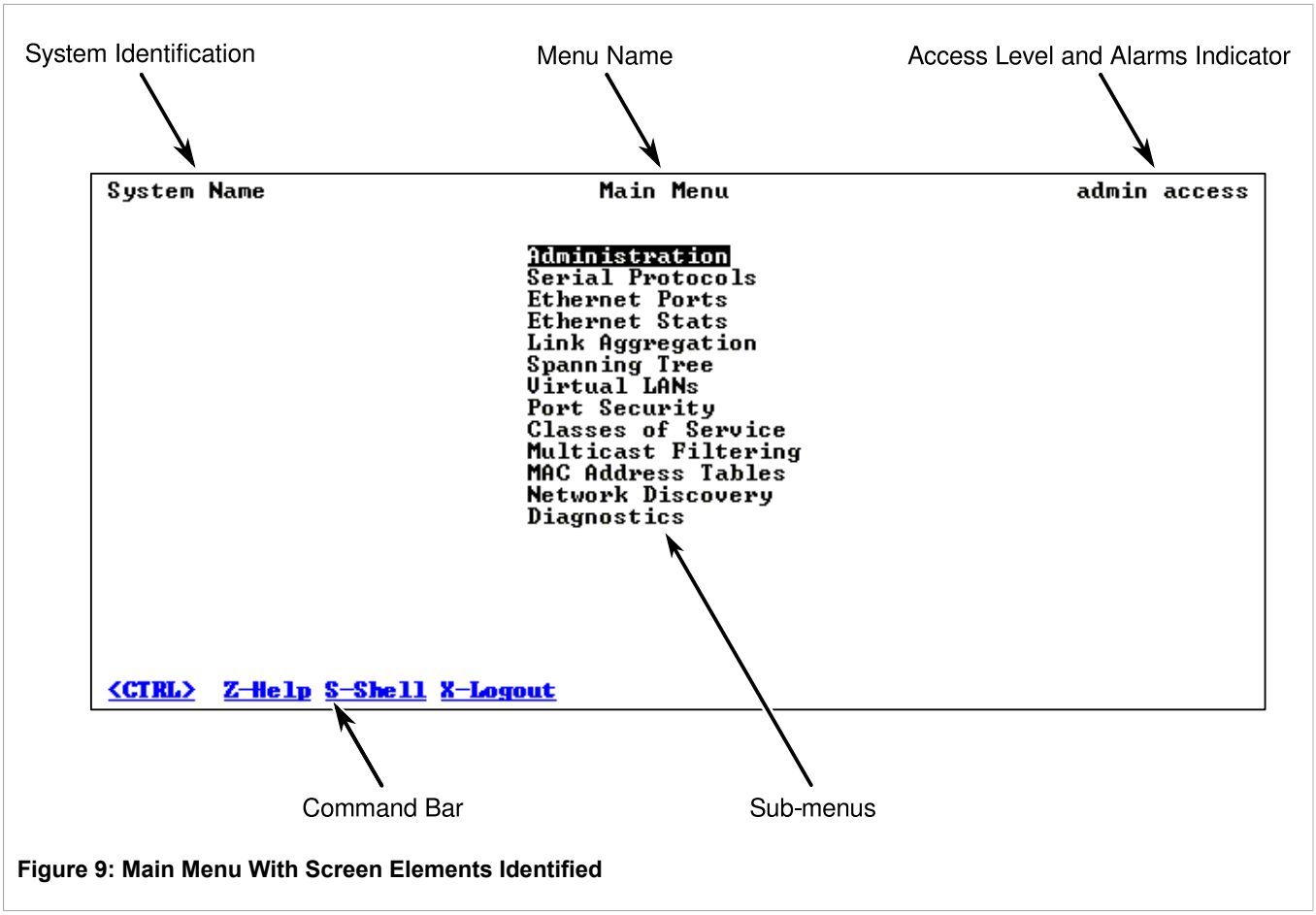


Figure 9: Main Menu With Screen Elements Identified

The command bar offers a list of commands that apply to the currently displayed menu. These commands include:

- <Ctrl-Z> to display help on the current command or data item
- <Ctrl-S> to switch to the CLI shell
- <Ctrl-Up/Down> to jump to next/previous page of a status display

The main menu also provides a <Ctrl-X> command, which will terminate the session. This type of menu is accessible via serial console, telnet session and SSH session.

Section 2.1.3
Making Configuration Changes

When changing a data item, the user selects the data item by the cursor keys and then pressing the enter key. The cursor will change position to allow editing of the data item.

Typing a new value after pressing enter always erases the old parameter value. The left and right cursor keys can be used to position the edit point without erasing the old parameter value. The up and down cursor keys can be used to cycle through the next higher and lower values for the parameter.

After the parameter has been edited, press enter again to change other parameters. When all desired parameters have been modified, press <Ctrl-A> to apply changes. The switch will automatically prompt you to save changes when you leave a menu in which changes have been made.

Some menus will require you to press <Ctrl-I> to insert a new record of information and <Ctrl-L> to delete a record.

Section 2.1.4
Updates Occur In Real Time

All configuration and display menus present the current values, automatically updating if changed from other user interface sessions or SNMP. All statistics menus will display changes to statistics as they occur.

Section 2.1.5
Alarm Indications Are Provided

Alarms are events for which the user is notified through the Diagnostics sub-menu. All configuration and display menus present an indication of the number of alarms (in the upper right hand corner of the screen) as they occur, automatically updating as alarms are posted and cleared.

Section 2.1.6
The CLI Shell

The user interface provides a Command Line Interface shell for operations that are more easily performed at the command line. You may switch back and forth from the menu system and shell by pressing <Ctrl-S>. For more information on the capabilities of the shell please refer to Section 1.7, “Using the CLI Shell”.

Section 2.2
The ROS Secure Shell Server

Section 2.2.1
Using a Secure Shell to Access the User Interface

SSH (Secure Shell) is a network protocol which provides a replacement for insecure remote login and command execution facilities, such as Telnet and remote shell. SSH encrypts traffic in both directions, preventing traffic sniffing and password theft.

NOTE
SSH requires a private and public key pair. A 1024-bit private/public key pair is built into the firmware by default. ROS will also auto-generate keys if user-generated keys are not provided. These keys are encrypted and obfuscated to hinder reverse engineering efforts.

Default and auto-generated keys can be superceded by uploading a key pair to the device. Siemens strongly encourages users to replace the default keys for improved security.

Private and public keys are stored in the `ssh.keys` *file. This file is write-only and can only be replaced by admin users. It can not be downloaded from the device. If the file is empty, a Default Keys In Use for SSH alarm is generated.*

SSH protocol version 2 is implemented in ROS. The authentication method is “keyboard-interactive” password authentication. A user logged in via SSH has the same privileges as one logged in via the console port.

Section 2.2.2
Using a Secure Shell to Transfer Files

ROS implements an SFTP server via SSH to transfer files securely. The file system visible on the switch has a single directory. The files in it are created at startup time and can be neither deleted nor renamed. Existing files can be downloaded from the switch. For example, firmware images may be downloaded for backup and log files may be downloaded for analysis. Some files may be overwritten by uploading a file of the same name to the switch, as would be done in order to upgrade the firmware.

Parameter	Description
dir/ls	list directory contents
get	download a file from the switch
put	upload a file to the switch

Parameter	Description
main.bin	main ROS firmware image
boot.bin	Switch bootloader image
config.csv	ROS configuration file
fpga.xsvf	FPGA configuration file
fpga416.xsvf	FPGA configuration file

Section 2.3
The ROS Web Server Interface

Section 2.3.1
Using a Web Browser to Access the Web Interface

A web browser uses a secure communications method called HTTPS (Hypertext Transfer Protocol Secure) to encrypt traffic exchanged with its clients. The web server guarantees that communications with the client are kept private. If the client requests access via an insecure HTTP port, it will be rerouted to the secure port. Access to the web server via HTTPS will be granted to a client that provides a valid user name / password pair.

NOTE
HTTPS requires SSL private and public keys. SSL private and public keys are built into the firmware by default. ROS will also auto-generate keys if user-generated keys are not provided. These keys are encrypted and obfuscated to hinder reverse engineering efforts.

Default and auto-generated keys can be superceded by uploading a key pair to the device. Siemens strongly encourages users to replace the default keys for improved security.

Custom private and public keys are stored in the `ssl.crt` file. This file is write-only and can only be replaced by admin users. It cannot be downloaded from the device. If the file is empty, a Default Keys In Use for SSL alarm is generated.

NOTE
It can happen that upon connecting to the ROS web server, a web browser may report that it cannot verify the authenticity of the server's certificate against any of its known certificate authorities. This is expected, and it is safe to instruct the browser to accept the certificate. Once the browser accepts the certificate, all communications with the web server will be secure.

Start a web browser session and open a connection to the switch by entering a URL that specifies its host name or IP address. For example, in order to access the unit at its factory default IP address, enter https://192.168.0.1. Once in contact with the switch, start the login process by clicking on the “Login” link. The resulting page should be similar to that presented below:

Figure 10: The ROS log in page

CAUTION!
To prevent unauthorized access to the device, make sure to change the default username and password for each user level (i.e. operator, guest and admin) before commissioning the device. It is recommended that each username and password be unique and customized to the user to add an additional level of security.

Enter the “admin” user name and the password for the admin user, and then click the “LogIn” button. The switch is shipped with a default administrator password of “admin”. After successfully logging in, the main menu appears.

Section 2.3.2

Customizing the Login Page

To display a custom welcome message, device information or any other information on the login page, add text to the “banner.txt” file. If the “banner.txt” file is empty, only the username and password fields will appear on the login page.

For more information, see Section 15.1, “Files Of Interest”.

Section 2.3.3

The Structure of the Web Interface

The user interface is organized as a series of linked web pages. The main menu provides the links at the top level of the menu hierarchy and allows them to be expanded to display lower-level links for each configuration subsystem.

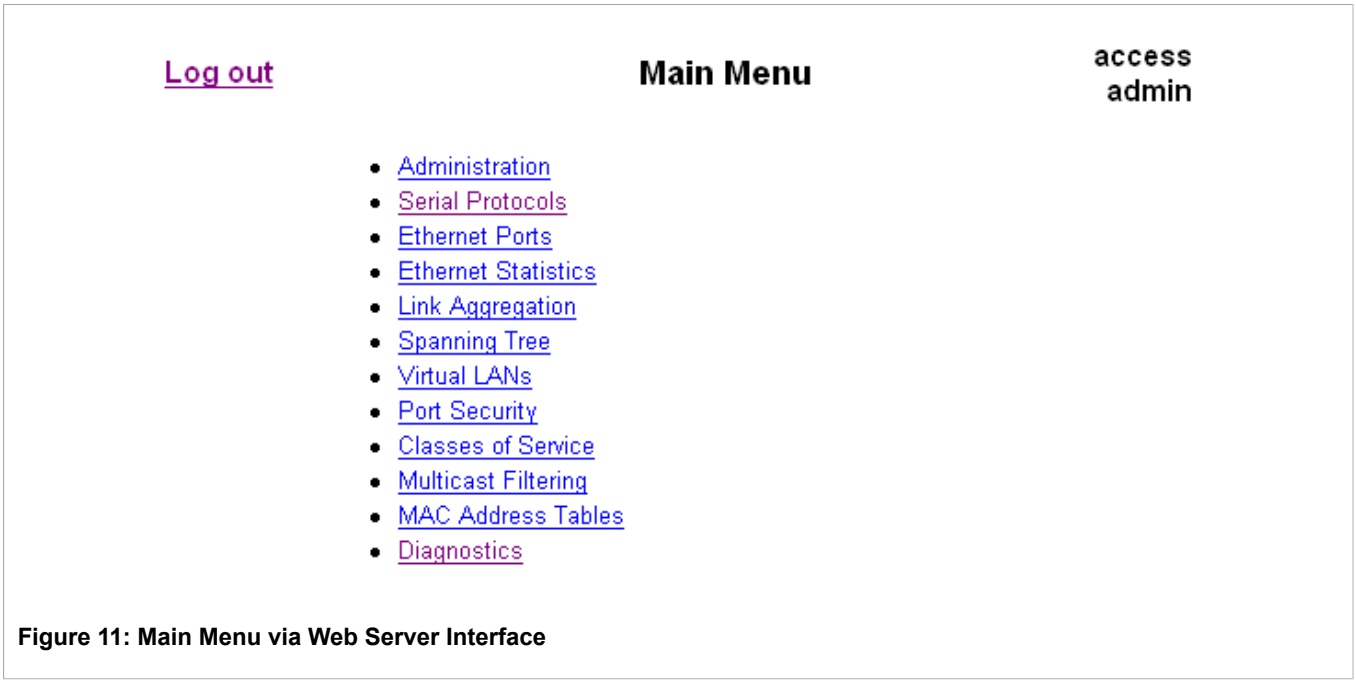


Figure 11: Main Menu via Web Server Interface

Every web page in the menu system has a common header section which contains:

- The System Name, as configured in the System Identification menu, is displayed in the top banner, in between elements of the Siemens logo.
- A “Log out” link at left and immediately below the banner, terminates the current web session.
- A “Back” link at left and below “Log out” links back to the previously viewed page.
- The menu title, in the center of the page and below the banner, is a link to a context-sensitive help page.

- The access level, e.g. “access admin”, is displayed by default at the right of the page and below the banner. If, however, any alarms are pending, the text will be replaced with a link which displays the number of pending alarms. Following this link displays a table of pending alarms.

Figure 12: Web Page Header Showing Alarms Link

Section 2.3.4
Making Configuration Changes

When changing a data item, the user selects the data item by selecting the field to edit with the mouse, entering a new value and clicking on the apply field. More than one parameter may be modified at a time.

Figure 13: Parameters Form Example

Some menus will require you to create or delete new records of information.

Section 2.3.5
Updating Statistics Displays

You may click the refresh button to update statistics displays.

Section 2.4
Administration Menu

The Administration menu provides ability to configure network and switch administration parameters.

Figure 14: Administration Menu

Section 2.5

IP Interfaces

These parameters provide the ability to configure IP connection parameters such as address, network, and mask.

The user can configure an IP interface for each subnet (VLAN). One of the interfaces is configured to be the management interface.

The following IP services are only available through the management interface: TFTP server, SNMP server, Telnet server, SSH server, RSH server, Web server, authentication using a RADIUS server, DHCP client, and BOOTP client.

Different IP interfaces must not overlap; that is, the subnet mask must be unique.

The RS416 supports the configuration of 255 IP interfaces. In VLAN unaware mode, only one IP interface can be configured.

On non-management interfaces, only static IP addresses can be assigned.

On the management interface, the user can choose from the following IP Address types: Static, DHCP, BOOTP and Dynamic. Static IP Address type refers to the manual assignment of an IP address while DHCP, BOOTP and Dynamic IP Address types refer to the automatic assignment of an IP address.

DHCP is widely used in LAN environments to dynamically assign IP addresses from a centralized server, which reduces the overhead of administrating IP addresses.

BOOTP is a subset of the DHCP protocol. ROS supports the transfer of a BOOTFILE via BOOTP. The BOOTFILE represents any valid ROS file such as config.csv. The name of BOOTFILE on the BOOTP server must match the corresponding ROS file.

The Dynamic IP Address type refers to a combination of the BOOTP and DHCP protocols. Starting with BOOTP, the system will try BOOTP and DHCP in a round-robin fashion until it receives a response from the corresponding server.

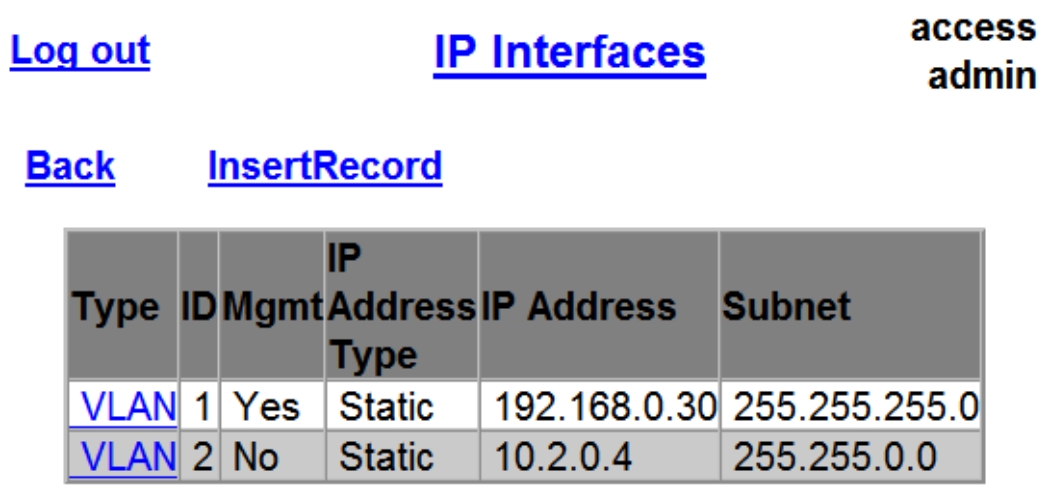


Figure 15: IP Interfaces Table

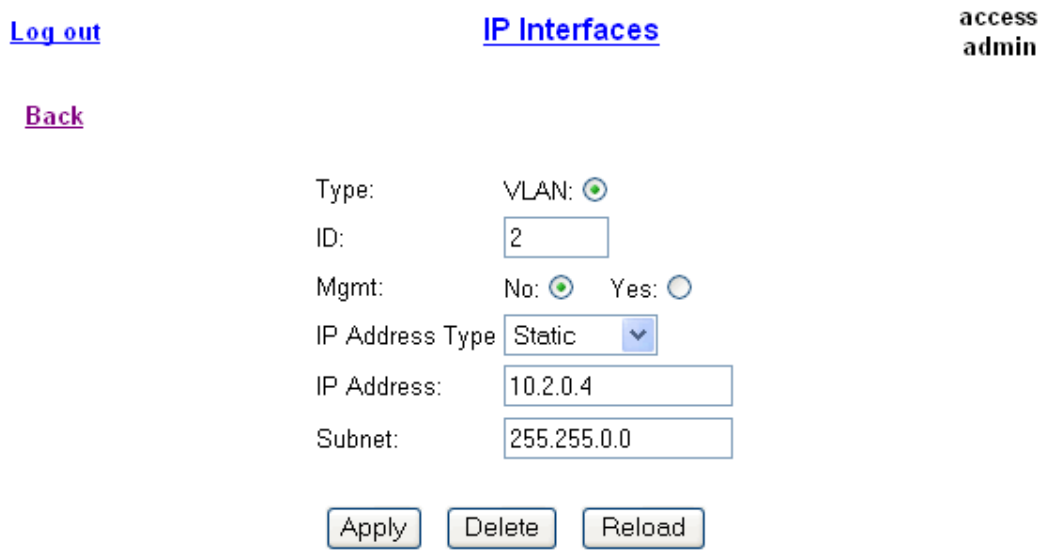


Figure 16: IP Interfaces Form

NOTE

The IP address and mask configured for the management VLAN are not changed when resetting all configuration parameters to defaults and will be assigned a default VLAN ID of 1. Changes to the IP address take effect immediately. All IP connections in place at the time of an IP address change will be lost.

NOTE

*You can use the ROS web interface to change the **IP Address Type** of the management interface from **Static** to **DHCP**. However, after doing so, you cannot use the web interface to change the **IP Address Type** back to **Static** and set an IP address. If you need to change the **IP Address Type** of*

*the management interface from **DHCP** to **Static**, configure the setting through a telnet, SSH, RSH, or serial port connection, or upload a new configuration file to the device.*

Parameter	Description
Type	**Synopsis:** { VLAN } **Default:** VLAN Specifies the type of the interface for which this IP interface is created.
ID	**Synopsis:** 1 to 4094 **Default:** 1 Specifies the ID of the interface for which this IP interface is created. If the interface type is VLAN, this represents the VLAN ID.
Mgmt	**Synopsis:** { No, Yes } **Default:** No Specifies whether the IP interface is the device management interface.
IP Address Type	**Synopsis:** { Static, Dynamic, DHCP, BOOTP } **Default:** Static Specifies whether the IP address is static or is dynamically assigned via DHCP or BOOTP. The Dynamic option automatically switches between BOOTP and DHCP until it receives a response from the relevant server. The Static option must be used for non-management interfaces.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 **Default:** 192.168.0.1 Specifies the IP address of this device. An IP address is a 32-bit number that is notated by using four numbers from 0 through 255, separated by periods. Only a unicast IP address is allowed, which ranges from 1.0.0.0 to 233.255.255.255.
Subnet	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 **Default:** 255.255.255.0 Specifies the IP subnet mask of this device. An IP subnet mask is a 32-bit number that is notated by using four numbers from 0 through 255, separated by periods. Typically, subnet mask numbers use either 0 or 255 as values (e.g. 255.255.255.0) but other numbers can appear.

Section 2.6
IP Gateways

These parameters provide the ability to configure gateways. A maximum of 10 gateways can be configured. When both the Destination and Subnet fields are both 0.0.0.0 (displayed as blank space), the gateway is a default gateway.

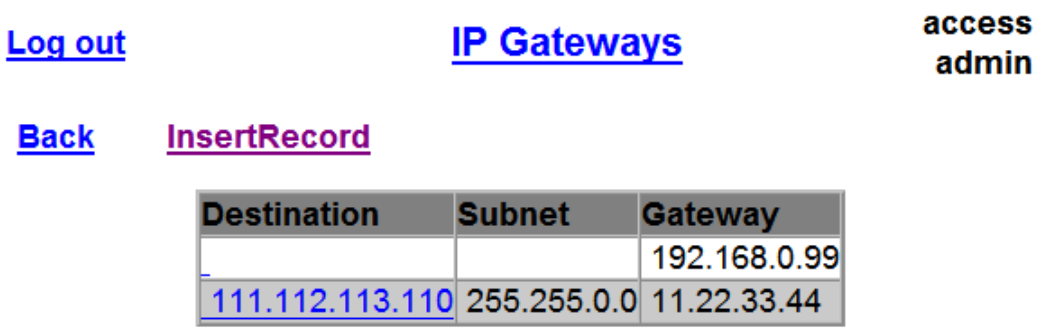


Figure 17: IP Gateways Form

Parameter	Description
Destination	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 **Default:** 0.0.0.0 Specifies the IP address of the destination device. An IP address is a 32-bit number that is notated by using four numbers from 0 through 255, separated by periods.
Subnet	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 **Default:** 0.0.0.0 Specifies the IP subnet mask of the destination. An IP subnet mask is a 32-bit number that is notated by using four numbers from 0 through 255, separated by periods. Typically, subnet mask numbers use either 0 or 255 as values (e.g. 255.255.255.0) but other numbers can appear.
Gateway	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 **Default:** 0.0.0.0 Specifies the gateway IP address. The gateway address must be on the same IP subnet as this device.

NOTE
The default gateway configuration will not be changed when resetting all configuration parameters to defaults.

Section 2.7
IP Services

These parameters provide the ability to configure properties for IP services provided by the device.

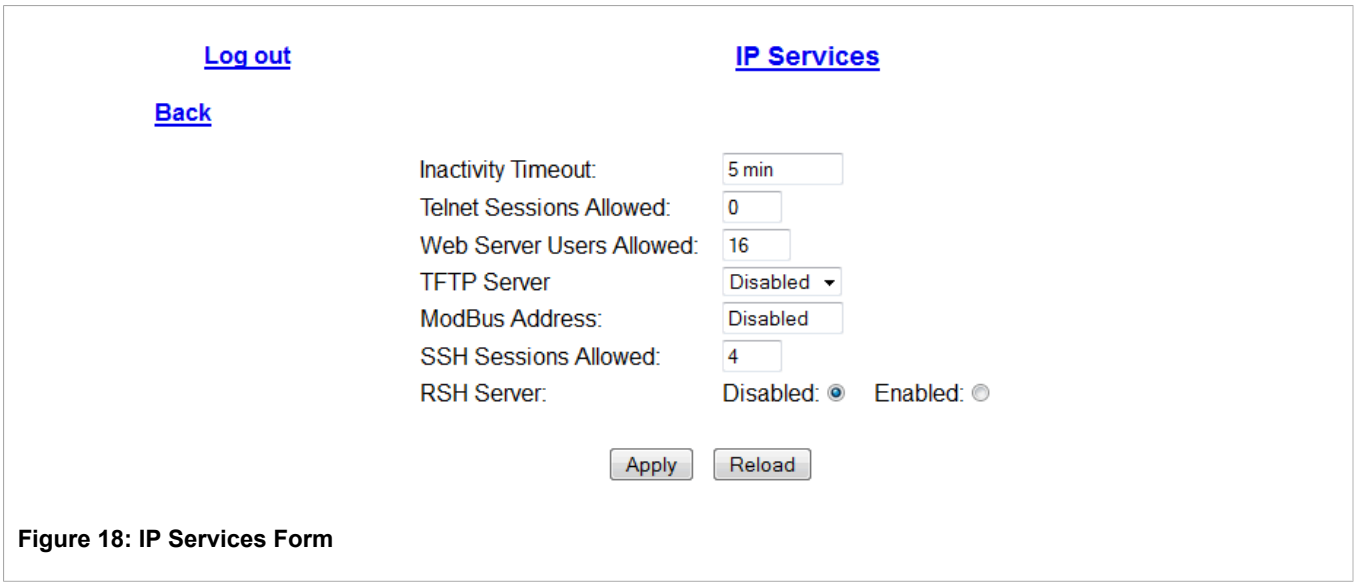


Figure 18: IP Services Form

Parameter	Description
Inactivity Timeout	**Synopsis:** 1 to 60 or { Disabled } **Default:** 5 min Specifies when the console will timeout and display the login screen if there is no user activity. A value of zero disables timeouts. For Web Server users maximum timeout value is limited to 30 minutes.
Telnet Sessions Allowed	**Synopsis:** 0 to 4 **Default:** 0 (controlled version) **Default:** 4 (non-controlled version) Limits the number of Telnet sessions. A value of zero prevents any Telnet access.
Web Server Users Allowed	**Synopsis:** 1 to 16 **Default:** 16 Limits the number of simultaneous web server users.
TFTP Server	**Synopsis:** { Disabled, Get Only, Enabled } **Default:** Disabled As TFTP is a very insecure protocol, this parameter allows the user to limit or disable TFTP Server access. DISABLED - disables read and write access to TFTP Server GET ONLY - only allows reading of files via TFTP Server ENABLED - allows reading and writing of files via TFTP Server
ModBus Address	**Synopsis:** 1 to 254 or { Disabled } **Default:** Disabled Determines the Modbus address to be used for Management through Modbus.
SSH Sessions Allowed (Controlled Version Only)	**Synopsis:** 1 to 4 **Default:** 4 Limits the number of SSH sessions.
RSH Server	**Synopsis:** { Disabled, Enabled } **Default:** Disabled (controlled version) **Default:** Enabled (non-controlled version) Disables/enables Remote Shell access.

Section 2.8
Data Storage

These parameters provide the ability to encrypt and password protect data in the CSV configuration file.

NOTE
Data encryption is not available in Non-Controlled (NC) versions of ROS.

When switching between Controlled and Non-Controlled (NC) versions of ROS, make sure data encryption is disabled. Otherwise, the NC version of ROS will ignore the encrypted configuration file and load the factory defaults.

Figure 19: Data Storage Form

Parameter	Description
Encryption	**Synopsis:** { On, Off } **Default:** Off Enable/disable encryption of data in configuration file.
Passphrase	**Synopsis:** 31 character ascii string This passphrase is used as a secret key to encrypt the configuration data. Encrypted data can be decrypted by any device configured with the same passphrase.
Confirm Passphrase	**Synopsis:** 31 character ascii string This passphrase is used as a secret key to encrypt the configuration data. Encrypted data can be decrypted by any device configured with the same passphrase.

NOTE
Only configuration data is encrypted. All comments and table names in the configuration file are saved as clear text.

NOTE
When sharing a configuration file between devices, make sure both devices have the same passphrase configured. Otherwise, the configuration file will be rejected.

NOTE
Encryption must be disabled before the device is returned to Siemens or the configuration file is shared with Customer Support.

IMPORTANT!
Never downgrade the ROS software version beyond ROS v3.12.0 when encryption is enabled. Make sure the device has been restored to factory defaults before downgrading.

Section 2.9
System Identification

The system identification is displayed in the sign-on screen and in the upper left hand corner of all ROS screens.

Figure 20: System Identification Form

Parameter	Description
System Name	**Synopsis:** Any 19 characters **Default:** System Name The system name is displayed in all ROS menu screens. This can make it easier to identify the switches within your network, provided that all switches are given a unique name.
Location	**Synopsis:** Any 49 characters **Default:** Location The location can be used to indicate the physical location of the switch. It is displayed in the login screen as another means to ensure you are dealing with the desired switch.
Contact	**Synopsis:** Any 49 characters **Default:** Contact The contact can be used to help identify the person responsible for managing the switch. You can enter name, phone number, email, etc. It is displayed in the login screen so that this person may be contacted, should help be required.

Section 2.10
Passwords

These parameters provide the ability to configure parameters for authorized and authenticated access to the device's services (HMI via Serial Console, Telnet, SSH, RSH, Web Server). Access to the switch can be authorized and authenticated via RADIUS or TACACS+ servers, or using locally configured passwords that are configured per user name and access level.

Note that access via the Serial Console is authorized first using local settings. If a local match is not found, RADIUS/TACACS+ will be used if enabled. For all other services, if RADIUS or TACACS+ is enabled for authentication and authorization, but is unreachable, the local settings will be used if configured.

To access the unit, the user name and password must be provided.

Three user names and passwords can be configured. They correspond to three access levels, which provide or restrict access to change settings and execute various commands within the device.

- *guest* users can view most settings, but may not change settings or run commands
- *operator* cannot change settings, but can reset alarms, clear statistics and logs
- *admin* user can change all the settings and run commands

CAUTION!
To prevent unauthorized access to the device, make sure to change the default username and password for each user level (i.e. operator, guest and admin) before commissioning the device. It is recommended that each username and password be unique and customized to the user to add an additional level of security.

When creating a new password, make sure it adheres to the following rules:

- Must not be less than 6 characters in length.
- Must not include the username or any 4 continous alphanumeric characters found in the username. For example, if the username is Subnet25, the password may not be subnet25admin or subnetadmin. However, net25admin or Sub25admin is permitted.
- Must have at least one alphabetic character and one number. Special characters are permitted.
- Must not have more than 3 continuously incrementing or decrementing numbers. For example, Sub123 and Sub19826 are permitted, but Sub12345 is not.

An alarm will generate if a weak password is configured. Any password that does not satisfy the rules mentioned above will be considered a weak password by ROS. The weak password alarm can be disabled by user. For more information about disabling alarms, refer to Section 14.1.4, “Configuring Alarms”.

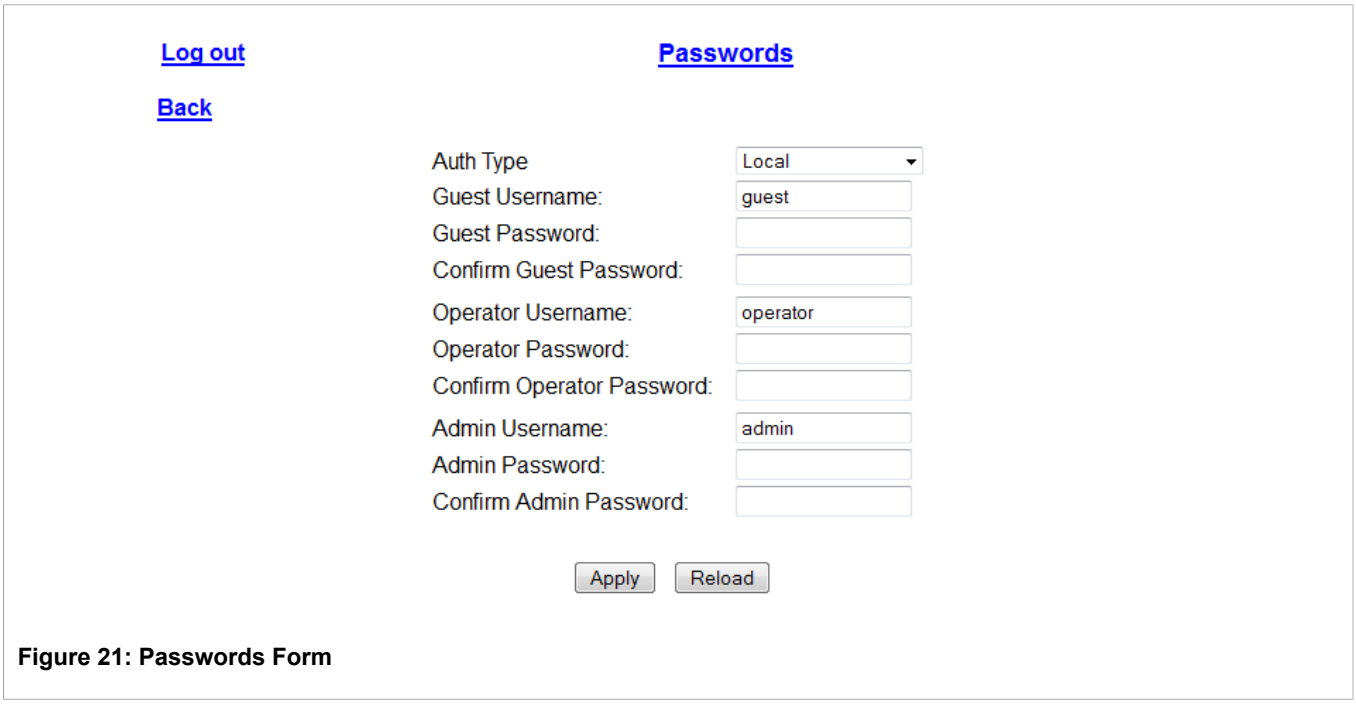


Figure 21: Passwords Form

Parameter	Description
Auth Type	**Synopsis:** { Local, RADIUS, TACACS+, RADIUSorLocal, TACACS+orLocal } **Default:** Local Password authentication can be performed using locally configured values, a remote RADIUS server, or a remote TACACS+ server. Setting this value to one of the combinations that includes RADIUS or TACACS+ requires that the Security Server Table be configured. • Local - authentication from the local Password Table • RADIUS - authentication using a RADIUS server • TACACS+ - authentication using a TACACS+ server • RADIUSOrLocal - authentication using RADIUS. If the server cannot be reached, authenticate from the local Password Table. • TACACS+OrLocal - authentication using TACACS+. If the server cannot be reached, authenticate from the local Password Table
Guest Username	**Synopsis:** 15 character ASCII string **Default:** guest Related password is in the Guest Password field; view only, cannot change settings or run any commands. Leave this parameter empty to disable this account.
Guest Password	**Synopsis:** 15 character ASCII string **Default:** guest Related user name is in the Guest Username field; view only, cannot change settings or run any commands.
Confirm Guest Password	**Synopsis:** 15 character ASCII string **Default:** None Confirm the input of the above Guest Password.
Operator Username	**Synopsis:** 15 character ASCII string **Default:** operator Related password is in the Oper Password field; cannot change settings; can reset alarms, statistics, logs, etc. Leave this parameter empty to disable this account.
Operator Password	**Synopsis:** 15 character ASCII string **Default:** operator Related user name is in the Oper Username field; cannot change settings; can reset alarms, statistics, logs, etc.
Confirm Operator Password	**Synopsis:** 15 character ASCII string **Default:** None Confirm the input of the above Operator Password.
Admin Username	**Synopsis:** 15 character ASCII string **Default:** admin Related password is in the Admin Password field; full read/write access to all settings and commands.
Admin Password	**Synopsis:** 15 character ASCII string **Default:** admin Related user name is in the Admin Username field; full read/write access to all settings and commands.
Confirm Admin Password	**Synopsis:** 15 character ASCII string **Default:** None Confirm the input of the above Admin Password.

Section 2.11
System Time Management

ROS running on the RS416 offers the following time-keeping and time synchronization features:

- Local hardware time keeping and time zone management
- IEEE 1588 master and slave clock operation
- IRIG-B input and output
- SNTP time synchronization

In addition to the local clock, the unit's time reference may be configured to be:

- An NTP server
- An IEEE 1588 master
- An IRIG-B source

The *System Time Manager* option within the ROS Administration menu fully configures time keeping functions on a ROS-based device:

Figure 22: System Time Manager Menu

Section 2.11.1
Time-Keeping Protocol Fundamentals

This section describes the time-keeping protocols supported by the RS416.

Section 2.11.1.1
Precision Time Protocol (PTP) Fundamentals

The IEEE 1588 working group PTP (Precise Timing Protocol) standard details a method of synchronizing clocks over networks, including Ethernet. RUGGEDCOM switches support PTP version 2 which is defined in the IEEE 1588 – 2008 standard.

IEEE 1588 PTP is a distributed protocol that allows multiple clocks in a network to synchronize with one another. These clocks are organized into a master-slave synchronization hierarchy with a “grandmaster” clock at the top of the hierarchy, which determines the reference time for the entire system. Synchronization is achieved via the exchange of PTP timing messages. “Slave” clocks use the timing information in PTP messages to adjust their time to that of the “master” in their part of the hierarchy.

The PTP protocol executes within a logical scope called a “domain”. The time established via the protocol within one domain is independent of the time in other domains.

A PTP version 2 system may consist of a combination of both PTP-aware and PTP-unaware devices. There are five basic types of PTP device defined in the IEEE 1588 – 2008 standard:

- Ordinary Clocks
- Boundary Clocks
- End-to-End Transparent Clocks
- Peer-to-Peer Transparent Clocks
- Management Nodes

The RS416 supports “Ordinary Clock” mode. The Ordinary Clock can be either the grandmaster clock in a system or a slave clock in the master-slave hierarchy. The selection of grandmaster clock and slave clocks is based on the Best Master Clock (BMC) algorithm defined in the IEEE 1588 – 2008 standard.

The PTP protocol may operate at multiple OSI [1] layers depending on the timestamp reference point for event messages. System synchronization precision improves significantly the closer to the physical layer the timestamp reference point is taken.

Section 2.11.1.2
Clock Accuracy

Siemens has developed a system for classifying clock accuracy. In the context of RUGGEDCOM equipment, this characterizes how well a slave clock maintains synchronization with its master clock. The **Desired Clock Accuracy** is derived from the “clockAccuracy” attributes defined in the IEEE 1588 specification, and represents the instantaneous value of time offset between master and slave clocks.

Section 2.11.1.3
IRIG-B Fundamentals

The Inter-Range Instrumentation Group (IRIG) IRIG-B standard details the format of a signal encoding which contains the current day, hour, minute and second in UTC format, broadcast at the start of each second.

The RS416 can be ordered with one dedicated TTL-level output and one input, which operate in IRIG-B007 PWM (Pulse Width Modulated) mode. Note that IRIG-B006 is a subset of IRIG-B007.

The RS416 can be ordered with serial ports that provide IRIG-B output in addition to RS232 serial on each DB9 or RJ45 connector. Each of these ports may, under software control, provide either IRIG-B007 PWM or a generic PPS (Pulse Per Second) signal.

The name of an IRIG-B code format consists of a single letter followed by three digits. Each letter or digit reflects an attribute of the corresponding IRIG-B code as shown in the following table.

[1] OSI refers to the Open Systems Interconnection Reference Model.

Table:

First Letter	B	100 PPS
1st Digit	0	No carrier
	1	Amplitude modulation
2nd Digit	0	No carrier
	2	1 kHz (1 ms resolution)
3rd Digit	2	BCD (Binary Coded Decimal) time of year
	3	BCD time of year, SBS (Straight Binary Second)
	6	BCD time of year, BCD year
	7	BCD time of year, BCD year, SBS

Section 2.11.1.4

IRIG-B IEEE1344 Extensions

IRIG-B (Inter-range instrumentation group timecode B) is widely used in the electrical power industry to synchronize power system devices, such as breakers, relays and meters. IRIG-B has a pulse rate of 100 pulses-per-second with an index count of 10 milliseconds over its one-second time frame.

IRIG-B consists of 100 bits produced every second, 74 bits of which contain various time, date, time changes and time quality information of the time signal. There are three functional groups of bits in the IRIG-B time code:

- Binary Coded Decimal (BCD)
- Control Functions (CF)
- Straight Binary Seconds (SBS)

NOTE
RS416 supports IEEE C37.118, which is similar to IEEE1344, except the local time offset uses a reversed sign.

NOTE
IEEE1344 extensions are only available if a supporting BNC IRIG-B card is installed in the RS416 device.

IEEE1344 extensions use extra bits of the Control Functions (CF) portion of the IRIG-B time code. Within this portion of the time code, bits are designated for additional features, including:

- Calendar Year (now called BCDYEAR)
- Leap seconds, and leap seconds pending
- Daylight Saving Time (DST), and DST pending (Daytime time changes is one hour)
- Local time offset (half hour resolution)
- Time quality
- Parity
- Position identifiers

To be able to use these extra bits of information, power system devices and other equipment receiving the time code must be able to decode them.

The following diagram shows one use case of IRIG-B and boundary clock which does Telecom to Power profile conversion and IEEE1588 to IRIGB conversion.

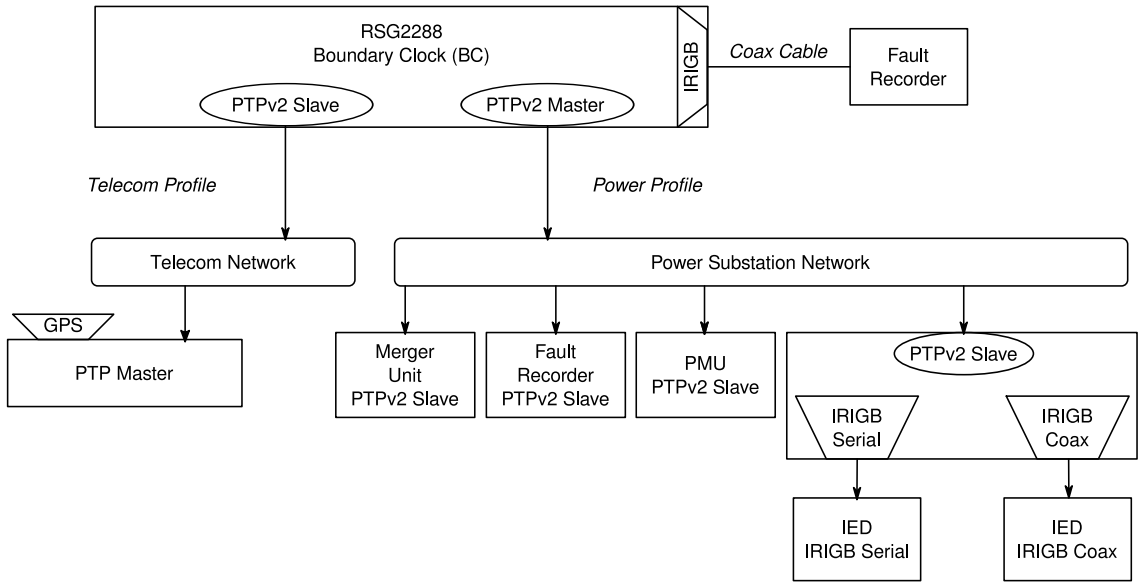


Figure 23: IRIG-B and Boundary Clock Use Case

NOTE

- *DSP information requires proper configuration of **DST Rule** and **DST Offset**, which reflects master configuration in IEEE1588/IEEE1344 gateway.*
- *Set the desired time configuration in all RS416 units and reset units. Do not change any configuration in the master once timing plane is running otherwise it may require resetting the IEEE1588/IEEE1344 gateway as well.*
- *Reset unit after configuration of IEEE1344.*

Section 2.11.2

Configuring Time and Date

This menu configures the current time, date, time zone, and DST (Daylight Savings Time) settings.

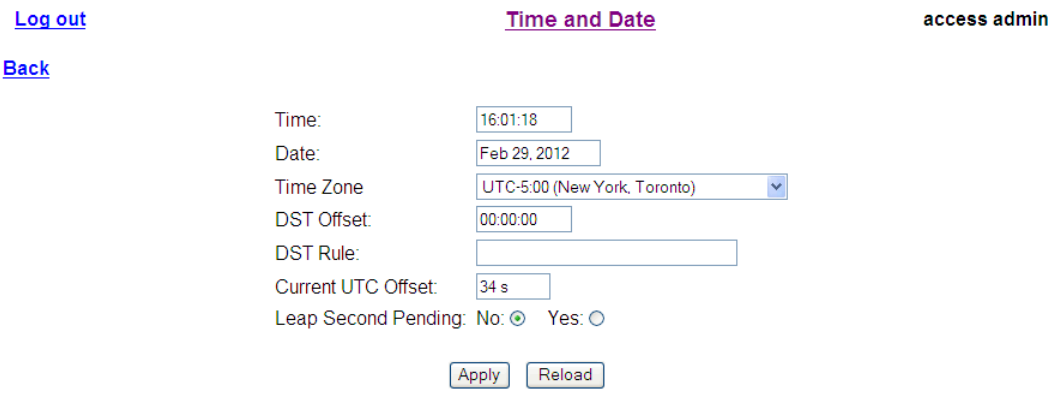


Figure 24: Time and Date Form

Parameter	Description
Time	**Synopsis:** HH:MM:SS This parameter enables both the viewing and setting of the local time.
Date	**Synopsis:** MMM DD, YYYY This parameter enables both the viewing and setting of the local date.
Time Zone	**Synopsis:** { UTC-12:00 (Eniwetok, Kwajalein), UTC-11:00 (Midway Island, Samoa), UTC-10:00 (Hawaii), UTC-9:00 (Alaska), UTC-8:00 (Los Angeles, Vancouver), UTC-7:00 (Calgary, Denver), UTC-6:00 (Chicago, Mexico City), UTC-5:00 (New York, Toronto), UTC-4:00 (Caracas, Santiago), UTC-3:30 (Newfoundland), UTC-3:00 (Brasilia, Buenos Aires), UTC-2:00 (Mid Atlantic), UTC-1:00 (Azores), UTC-0:00 (Lisbon, London), UTC+1:00 (Berlin, Paris, Rome), UTC+2:00 (Athens, Cairo, Helsinki), UTC+3:00 (Baghdad, Moscow), UTC+3:30 (Teheran), UTC+4:00 (Abu Dhabi, Kazan, Muscat), UTC+4:30 (Kabul), UTC+5:00 (Islamabad, Karachi), UTC+5:30 (Calcutta, New Delhi), UTC+5:45 (Kathmandu), UTC+6:00 (Almaty, Dhaka), UTC+6:30 (Rangoon), UTC+7:00 (Bangkok, Hanoi), UTC+8:00 (Beijing, Hong Kong) UTC+9:00 (Seoul, Tokyo), UTC+9:30 (Adelaide, Darwin), UTC+10:00 (Melbourne, Sydney), UTC+11:00 (Magadan, New Caledonia), UTC+12:00 (Auckland, Fiji) } **Default:** UTC-0:00 (Lisbon, London) This setting enables the conversion of UTC (Universal Coordinated Time) to local time.
DST Offset	**Synopsis:** HH:MM:SS Default:00:00:00 This parameter specifies the amount of time to be shifted forward/backward when DST begins and ends. For example, for most of the USA and Canada, DST time shift is 1 hour (01:00:00) forward when DST begins and 1 hour backward when DST ends.
DST Rule	**Synopsis:** mm.n.d/HH:MM:SS mm.n.d/HH:MM:SS Default: This parameter specifies a rule for time and date when the transition between Standard and Daylight Saving Time occurs. • mm - Month of the year (01 - January, 12 - December) • n - week of the month (1 - 1st week, 5 - 5th/last week) • d - day of the week (0 - Sunday, 6 - Saturday) • HH - hour of the day (0 - 24) • MM - minute of the hour (0 - 59)

Parameter	Description
	• SS - second of the minute (0 - 59) Example: The following rule applies in most of the USA and Canada: 03.2.0/02:00:00 11.1.0/02:00:00 In the example, DST begins on the second Sunday in March at 2:00am, and ends on the first Sunday in November at 2:00am.
Current UTC Offset	**Synopsis:** 0 s to 1000 s **Default:** 34 s Coordinated Universal Time (UTC) is a time standard based on International Atomic Time (TAI) with leap seconds added at irregular intervals to compensate for the Earth's slowing rotation. The Current UTC Offset parameter allows the user to adjust the difference between UTC and TAI. The International Earth Rotation and Reference System Service (IERS) observes the Earth's rotation and nearly six months in advance (January and July) a Bulletin-C message is sent out, which reports whether or not to add a leap second in the end of June and December. Please note that change in the Current UTC Offset parameter will result in a temporary disruption in the timing network.
Leap Second Pending	**Synopsis:** { No , Yes } **Default:** No This parameter allows user to manage the leap second event. A leap second is a second added to Coordinated Universal Time (UTC) in order to keep it synchronized with astronomical time. The International Earth Rotation and Reference System Service (IERS) observes the Earth's rotation and nearly six months in advance (January and July) a Bulletin-C message is sent out, which reports whether or not to add a leap second in the end of June and December. This parameter must set at least 5 minutes in advance before the occurrence of leap second event.

Section 2.11.3

Configuring NTP Service

ROS may optionally be configured to refer periodically to a specified NTP server to correct any accumulated drift in the on-board clock. ROS will also serve time via SNTP to hosts that request it.

Two NTP servers (primary and secondary) may be configured for the device. The primary server is contacted first upon each attempt to update the system time. If the primary server fails to respond, the secondary server is contacted. If either the primary or secondary server fails to respond, an alarm is raised.

NOTE
If it is desired that NTP provide the time reference for the unit, the Time Source parameter must be set to "NTP Server" in the Section 2.11.6, "Time Source Selection" menu.

NOTE
If the time source is an NTP server, make sure the IP address for the server is configured before enabling NTP server as the time source, otherwise the device will need to be reset. This is important, for example, when the time signal is output using IRIG-B.

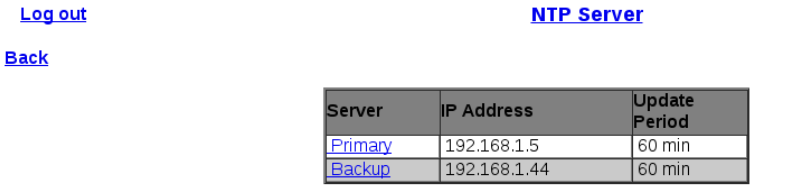


Figure 25: NTP Server List

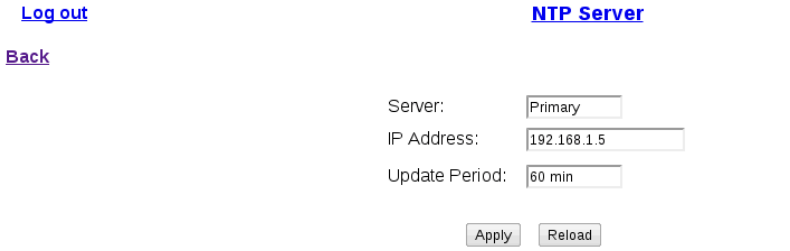


Figure 26: NTP Server Form

Parameter	Description
Server	**Synopsis:** Primary, Secondary This field displays the chosen NTP server. The remaining fields on this form correspond to the chosen server.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 Default: This parameter specifies the IP address of an (S)NTP server ((Simple) Network Time Protocol); programming an address of '0.0.0.0' disables SNTP requests. This device is an SNTP client which may connect to only one server. If a server address is programmed then a manual setting of the time will be overwritten at the next update period.
Update Period	**Synopsis:** 1 to 1440 **Default:** 60 min This setting determines how frequently the (S)NTP server is polled for a time update. If the server cannot be reached, three attempts are made at one-minute intervals and then an alarm is generated, at which point the programmed rate is resumed.

Section 2.11.4

Configuring Precision Time Protocol (PTP, IEEE 1588)

The *Precision Time Protocol* link on the main web menu leads to four sub-menus that configure the operation of IEEE 1588 PTP on the RS416.

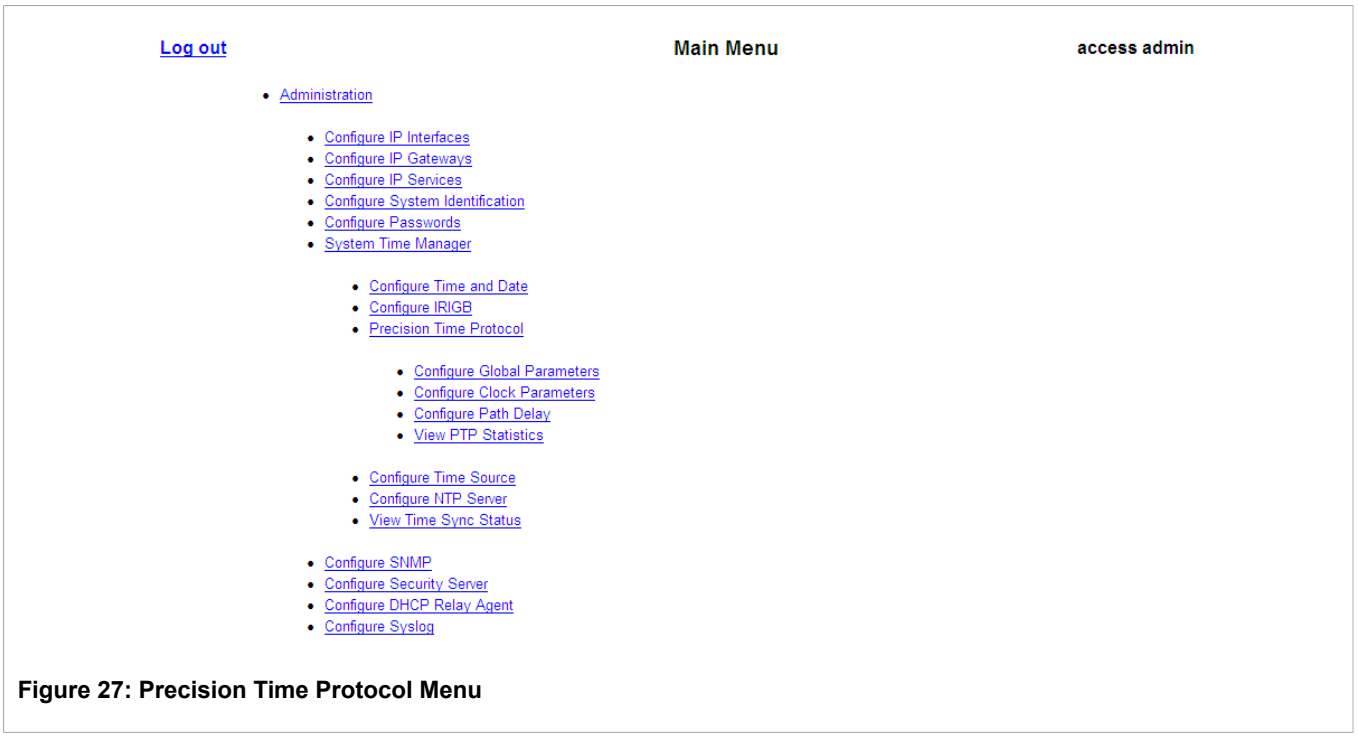


Figure 27: Precision Time Protocol Menu

Section 2.11.4.1

Global PTP Parameters

This menu configures system PTP parameters.

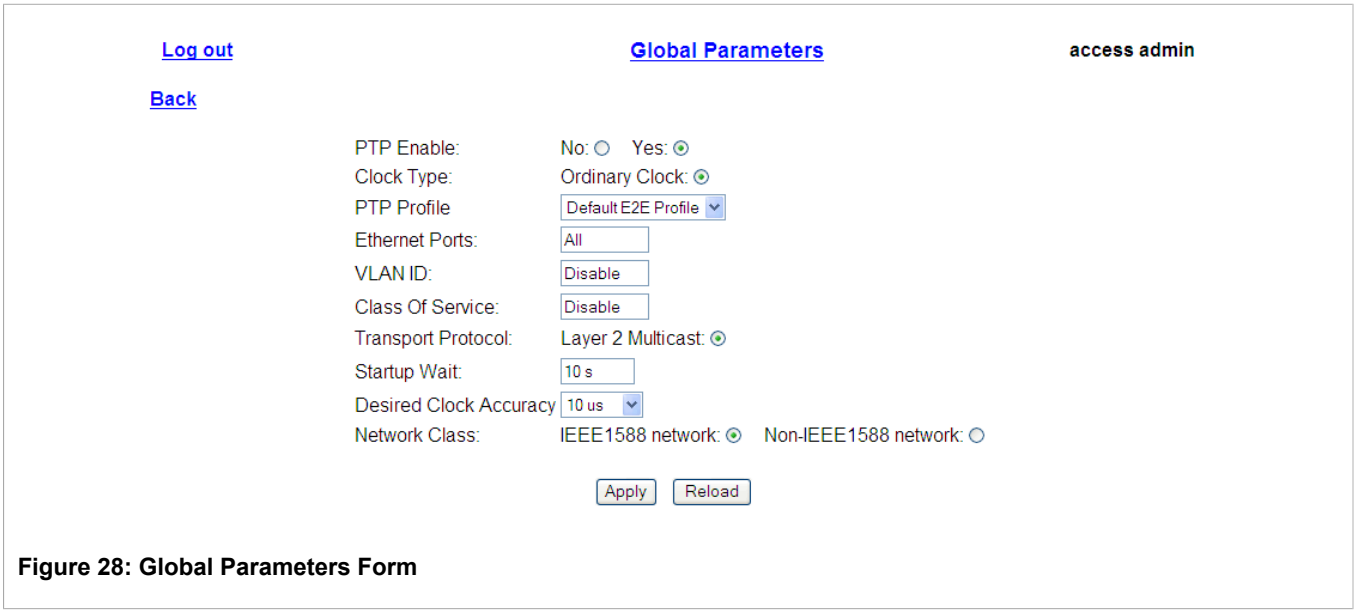


Figure 28: Global Parameters Form

Parameter	Description
PTP Enable	**Synopsis:** { No, Yes } **Default:** No

Parameter	Description
	Enables PTP (Precision Time Protocol) protocol.
Clock Type	{ Ordinary Clock } Default: Ordinary Clock Selects PTP (Precision Time Protocol) clock type such as Ordinary Clock (OC). If configure as an Ordinary Clock the device acts as either a master or slave except if IRIGB or GPS interface is installed. In that case, the device either acts as a master or remains in a passive state.
PTP Profile	**Synopsis:** { Power Profile, Default P2P Profile, Default E2E Profile, Custom Profile } **Default:** Power Profile Selects PTP (Precision Time Protocol) clock profile. PTP profile is the set of allowed PTP features applicable to a device. Supported profiles are Power Profile (IEEE C37.238), Default P2P (Peer-to-Peer) Profile as defined in IEEE1588-2008 standard with layer 2 transport, Default E2E (End-to-End) Profile as defined in IEEE1588-2008 standard with layer 2 transport, and user defined Custom Profile.
Ethernet Ports	**Synopsis:** Any combination of numbers valid for this parameter **Default:** All Selects which Ethernet ports will take part in PTP (Precision Time Protocol) message exchanges.
VLAN ID	**Synopsis:** 1 to 4095 or { Disable } **Default:** 1 The VLAN ID associated with untagged (and 802.1p priority tagged) frames received on this port. Frames tagged with a non-zero VLAN ID will always be associated with the VLAN ID retrieved from the frame tag. Frames tagged with a zero VLAN ID will always be associated with the VLAN ID 1 unless this parameter is configured.
Class Of Service	**Synopsis:** 1 to 7 or { Disable } **Default:** 4 Sets the frame priority of PTP data, as set out in the IEEE 802.1p specification. IEEE 802.1p defines eight different classes of service, usually expressed through the 3-bit priority field in an IEEE 802.1Q header added to the Ethernet frame. Enabling the VLAN option and a Class Of Service set to 'Disable', is equivalent to priority '0' in terms of IEEE 802.1p specification.
Transport Protocol	Synopsis: { Layer 2 Multicast } Default: Layer 2 Multicast Layer 2 (Ethernet) multicast transport for PTP (Precision Time Protocol) messages.
Startup Wait	**Synopsis:** 0 s to 3600 s **Default:** 10 s Normally start-up time of non-GPS master is less than GPS enabled master (i.e. acquiring GPS lock). This parameter provides ability to bootstrap the PTP network in more orderly fashion.
Desired Clock Accuracy	**Synopsis:** 50 ns, 100 ns, 250 ns, 1 us, 2.5 us, 10 us, 25 us, 100 us, 250 us, 1 ms, 2.5 ms, 10 ms, 25 ms, 100 ms, 250 ms Default: 100 us This parameter allows user to configure desired clock accuracy. The desired clock accuracy represents instantaneous value of time offset between master and slave clocks. System will generate an alarm if time offset from master exceed the desired accuracy.
Network Class	**Synopsis:** { IEEE1588 network, Non-IEEE1588 network } **Default:** IEEE1588 network Clock servo stability is highly dependent on network personality. This parameter allows user to configure network personality to reflect their setup. For example, whether all devices in the timing plane are IEEE1588 aware (IEEE1588 network) or timing plane include non-IEEE1588 devices as well (non-IEEE1588 network). Please note that IEEE1588 network is independent of traffic load. Only E2E mechanism is applicable to non-IEEE1588 network.

Section 2.11.4.2

Clock Parameters

This menu configures PTP (Precision Time Protocol) Ordinary Clock attributes.

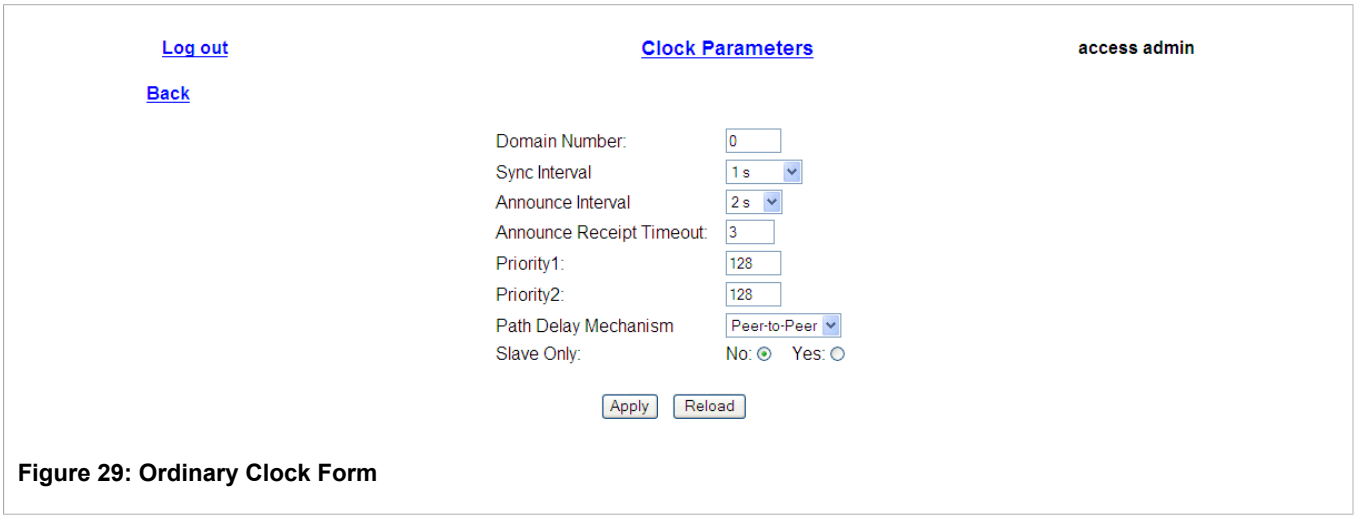


Figure 29: Ordinary Clock Form

Parameter	Description
Domain Number	**Synopsis:** 0 to 127 **Default:** 0 Selects PTP (Precision Time Protocol) domain number. Domain is basically a logical grouping of PTP clocks that synchronize to each other using the PTP protocol.
Sync Interval	**Synopsis:** 125 ms, 250 ms, 500 ms, 1 s, 2 s **Default:** 1 s Selects PTP (Precision Time Protocol) Sync interval (mean time interval between successive Sync messages) in seconds. Sync messages are periodically sent by Master Clock which provides time of day information to PTP Slave Clock(s).
Announce Interval	**Synopsis:** { 1s, 2s, 4s, 8s, 16s, 32s } **Default:** 1 s Selects PTP (Precision Time Protocol) announce interval (mean time interval between successive Announce messages) in seconds. Announce messages are periodically sent by Master Clock which provide status and characterization information about it. The Announce message is used to establish the synchronization hierarchy.
Announce Receipt Timeout	**Synopsis:** 2 to 10 **Default:** 3 Selects PTP (Precision Time Protocol) announce receipt timeout. This parameter specifies the number of Announce Interval that have to pass without receipt of an Announce message. This parameter is part of BMC (Best Master Clock) algorithm. Please note that change in this parameter may be disruptive.
Priority1	**Synopsis:** 0 to 255 **Default:** 128 Selects PTP (Precision Time Protocol) clock priority1 during the execution of Best Master Clock (BMC) algorithm. Lower value takes precedence. The operation of the best master clock algorithm selects clocks from a set with a lower value of priority1 over clocks from a set with a greater value of priority1.
Priority2	**Synopsis:** 0 to 255 **Default:** 128 Selects PTP (Precision Time Protocol) clock priority2 during the execution of Best Master Clock (BMC) algorithm. Lower value takes precedence. In the event that the operation of

Parameter	Description
	the best master clock algorithm fails to order the clocks based on the values of priority1, clockClass, clockAccuracy and scaledOffsetLogVariance, the priority2 attribute allows the creation of upto 256 priorities to be evaluated before the tie-breaker. The tie-breaker is based on the clock identity.
Path Delay Mechanism	**Synopsis:** { Disabled, Peer-to-Peer, End-to-End } **Default:** Peer-to-Peer Selects PTP (Precision Time Protocol) delay mechanism functionality. There are two mechanisms used in PTP to measure the propagation delay between PTP ports. Peer delay mechanism measures the port-to-port propagation time such as link delay and frame residence time. The E2E (End-to-End) delay mechanism measures the message propagation time between master and slave clocks. The peer delay mechanism is independent of whether the PTP port is a master or a slave. Please note that the peer delay mechanism does not interwork with path delay measurements based on the E2E (also called request-response) delay mechanism.
Slave Only	**Synopsis:** { No, Yes } **Default:** No Forces an ordinary clock to be a slave only clock. A slave only clock can never enter the master state. User can combine slave only and Transparent Clock functionality. Please note that a boundary clock must not be configured as a slave only clock.

Section 2.11.4.3
Delay Mechanism Settings

This menu configures PTP (Precision Time Protocol) delay mechanism attributes.

Figure 30: Delay Mechanism Form

Parameter	Description
P2P Request Interval	**Synopsis:** { 1 s, 2 s, 4 s, 8 s, 16 s, 32 s } **Default:** 1 s Selects the PTP delay request interval (mean time interval between successive delay request messages), in seconds. The peer delay mechanism measures the port-to-port propagation time, such as the link delay, between two communicating ports supporting the peer delay mechanism.
E2E Request Interval	**Synopsis:** { 1 s, 2 s, 4 s, 8 s, 16 s, 32 s } **Default:** 1 s Selects the PTP delay request interval (mean time interval between successive delay request messages), in seconds. The E2E (also called request-response) delay mechanism measures the message propagation time between the master and slave clocks.

Section 2.11.4.4

Viewing PTP Statistics

The View PTP Statistics menu provides links to forms where you can view PTP Clock, Boundary Clock Slave, and Peer Delay statistics.

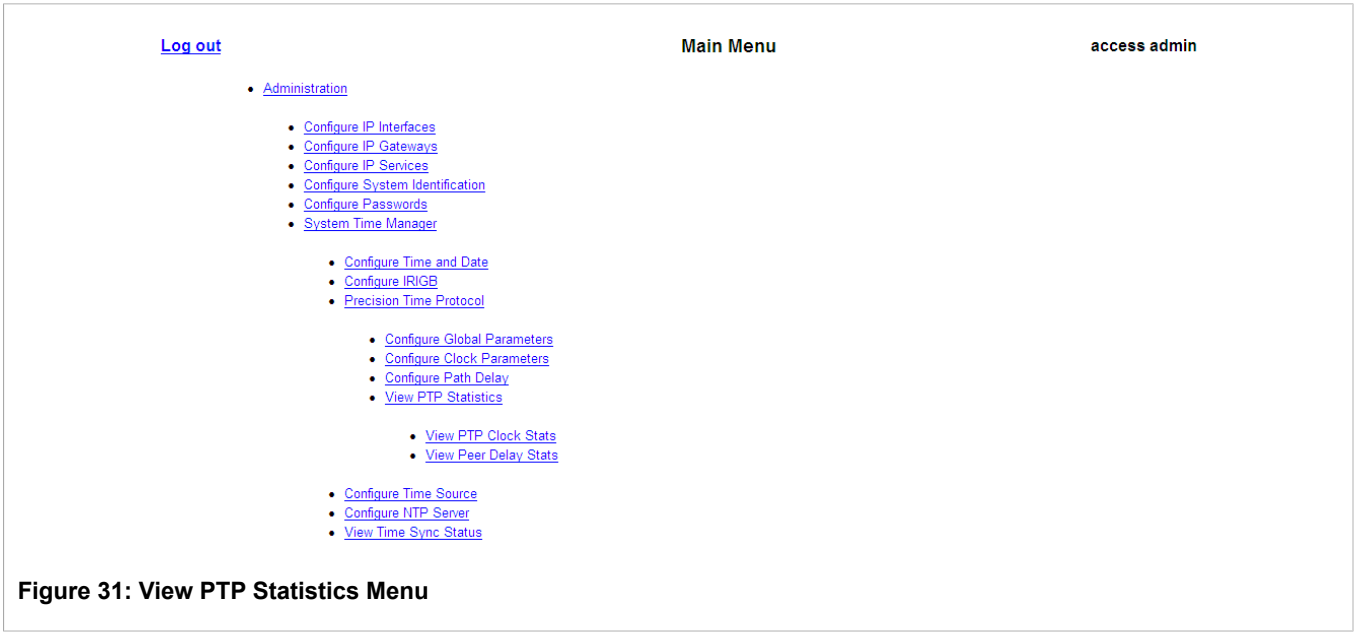


Figure 31: View PTP Statistics Menu

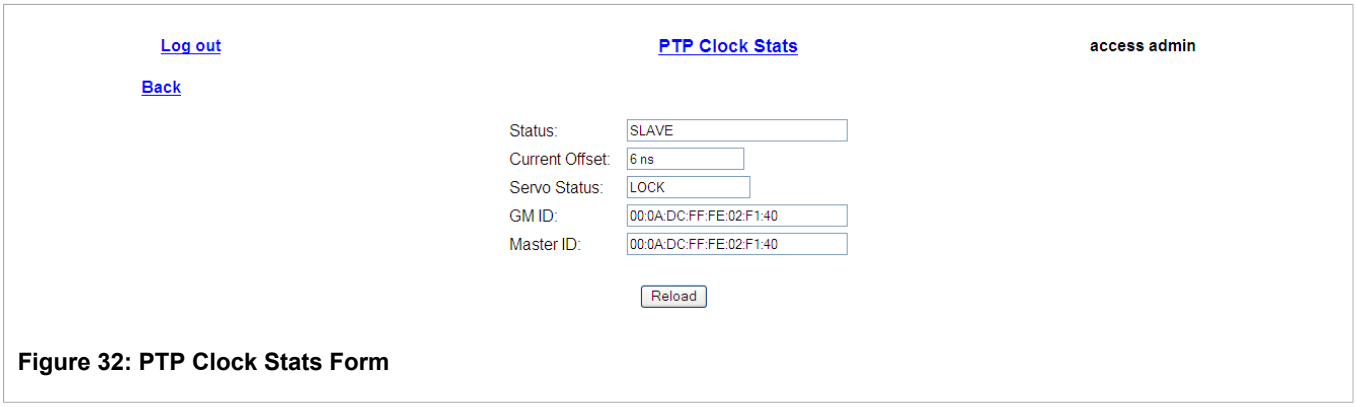


Figure 32: PTP Clock Stats Form

Parameter	Description
Status	**Synopsis:** Any 31 characters Shows the status of the PTP (Precision Time Protocol) node. If the device is configured as an Ordinary Clock, this field shows the status of the PTP state, such as MASTER, SLAVE, or LISTENING. If the device is configured as a Transparent Clock, this this field indicates the configuration setting.
Current Offset	**Synopsis:** -2147483647 ns to 2147483647 ns Shows the current time offset between the master and slave clocks, calculated according to the IEEE1588-2008 specification.
Servo Status	**Synopsis:** Any 15 characters Shows the status of the clock servo. The clock servo mechanism disciplines the system clock. If the clock accuracy is within the desired limits, the status is set to “lock”. Note that an alarm might occur convergence of the clock servo.

Parameter	Description
GM ID	**Synopsis:** Any 31 characters Shows the identity of the PTP (Precision Time Protocol) grandmaster clock. Note that the master clock may be the same as the grandmaster clock.
Master ID	**Synopsis:** Any 31 characters Shows the identity of the PTP (Precision Time Protocol) master clock. Note that the master clock may be the same as the grandmaster clock.

The Peer Delay Statistics form displays P2P (Peer To Peer) clock statistics for all ports. These statistics are updated every few seconds.

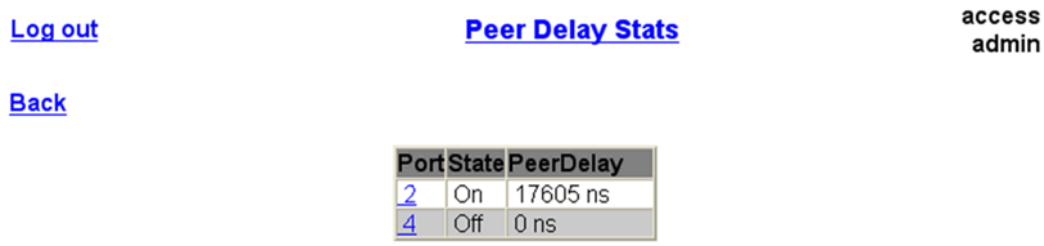


Figure 33: Peer Delay Statistics Form

Parameter	Description
Port	**Synopsis:** 1 to 11 The port number as seen on the front plate silkscreen.
State	**Synopsis:** x The status of the PTP port with respect to the P2P (Peer To Peer) delay mechanism.
PeerDelay	**Synopsis:** 0 ns to 2147483647 ns Peer delay in nanoseconds. The peer delay mechanism measures the port-to-port propagation time, such as the link delay, between two communicating ports supporting the peer delay mechanism.

Section 2.11.5
Configuring IRIG-B

This menu configures the output of the BNC IRIG-B port.

Figure 34: IRIG-B Configuration Menu

NOTE
If the IEEE 1344 is needed, make sure IEEE 1344 is enabled last when configuring time synchronization, otherwise the device will need to be reset.

Parameter	Description
TTL Output	**Synopsis:** { Off, PWM, PPS } **Default:** PWM Selects operational mode of IRIGB port. Possible options are PWM (Pulse Width Modulation) and PPS (Pulse per Second). PWM mode complies with IRIG Standard 200-04 and is capable of generating formats IRIGB006 and IRIGB007. PPS provides generic PPS interface to synchronize external devices.
IEEE 1344	**Synopsis:** { No, Yes } **Default:** No Selects IEEE-1344 IRIGB extensions (C37.118-2005), if a BNC IRIG-B card is installed. IEEE-1344 IRIGB extensions use extra bits of the Control Functions (CF) portion of the IRIGB time code. Within this portion of the time code, bits are designated for additional features, including: Calendar Year, Leap seconds, leap seconds pending, Daylight Saving Time (DST), DST pending, local time offset and time quality.

IRIG-B functionality for the serial port connectors is configured via the serial port setup menu.

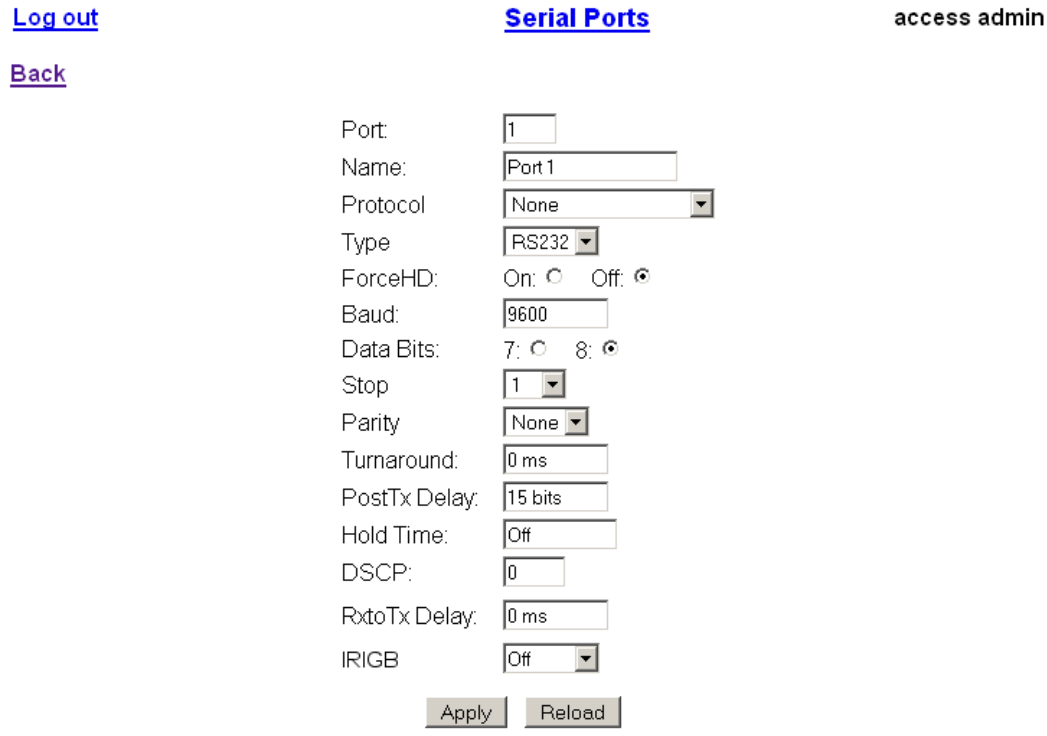


Figure 35: Serial Port Menu

A single field, *IRIGB* on the *Serial Ports* configuration form sets the operational mode of the IRIGB port per serial port:

Parameter	Description
IRIGB	**Synopsis:** { PWM, PPS, Off } **Default:** Off Selects the output mode of the IRIG-B pin on the corresponding serial port.

PWM (Pulse Width Modulation) mode complies with IRIG Standard 200-04 generating formats IRIGB006 and IRIGB007. In PPS mode, a pulse with a duration of 1 millisecond is output every second at the beginning of the second.

Section 2.11.6

Time Source Selection

This menu configures the reference time source to be used by the device for the local clock and for all served time references.

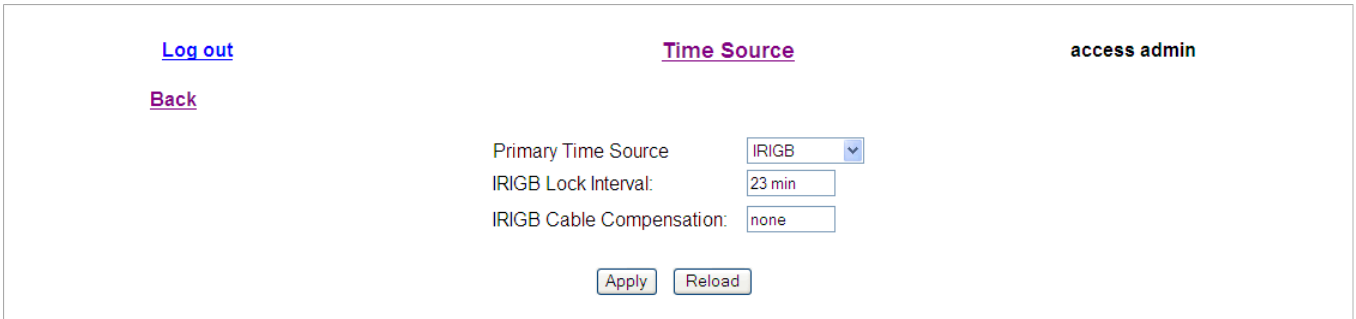


Figure 36: Time Source Form

Parameter	Description
Primary Time Source	**Synopsis:** { LOCAL CLK, IRIGB, IEEE1588, NTP Server } **Default:** LOCAL CLK To select time source that will discipline the local clock. Note that changing the time source may produce a step change in the time seen via any of the clock outputs.
IRIGB Lock Interval	**Synopsis:** 1 to 120 min or { Forever } **Default:** Forever To set time interval with in which GPS/IRIGB receiver should acquire lock to the time source. Normally GPS (or IRIGB) receiver needs couple of minutes to lock the signal. User should set reasonable time interval. If time interval expire with out acquire the lock then system start distributing the time using local clock.
IRIGB Cable Compensation	**Synopsis:** 1 to 50000 ns or { none } **Default:** none Cable compensation may be desired to compensate for a long cable run in order to minimize the timing inaccuracy.

Section 2.11.7

Time Synchronization Status

This menu provides summary information on the status of the time synchronization subsystem. It provides information related to:

- Which time source is acting as a primary time source.
- IRIG-B status.
- IEEE 1588 PTP status (i.e. Master or Slave).

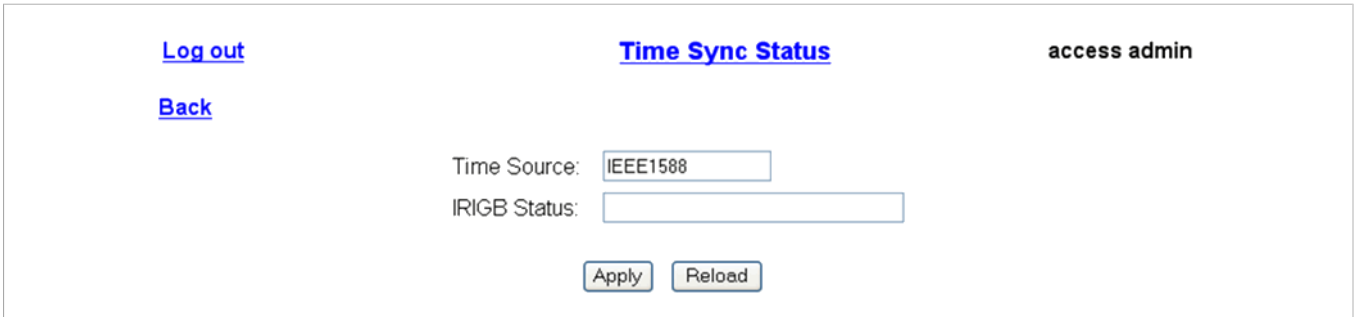


Figure 37: Time Sync Status Form

Parameter	Description
Time Source	**Synopsis:** Any 15 characters Displays the time source which is driving the system clock.
IRIGB Status	**Synopsis:** Any 31 characters The status of the IRIG-B clock source, whether the IRIG-B input is connected and if it is, whether the received signal is valid.

Section 2.11.8
PTP/IEEE1588 Frequently Asked Questions

This section presents commonly asked questions and notes on the configuration of PTP (Precision Time Protocol - IEEE1588) on the RS416.

Q: How do I configure a Peer to Peer (P2P) Master Clock?

A: Using the ROS menu interface, complete the following steps in order. Each step begins at **Administration** > **System Time Manager**:

1. **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Enable** to **`Yes`**.
2. **Precision Time Protocol** > **Configure Global Parameters**: set **Clock Type** to **`Ordinary Clock`**.
3. **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Profile** to **`Default P2P Profile`**.
4. **Precision Time Protocol** > **Configure Clock Parameters**: set **Priority1** to **`1`**.
5. **Configure Time Source**: set **Primary Time Source** to your primary time source, such as **`IRIGB`**, **`LOCAL_CLK`**, or **`NTP`**.

Q: How do I configure a P2P slave clock?

A: Using the ROS menu interface, complete the following steps in order. Each step begins at **Administration** > **System Time Manager**:

1. **Precision Time Protocol** > **Configure Global Parameters** > : set **PTP Enable** to **`Yes`**.
2. **Precision Time Protocol** > **Configure Global Parameters** > : set **Clock Type** to **`Ordinary Clock`**.
3. **Precision Time Protocol** > **Configure Global Parameters** > : set **PTP Profile** to **`Default P2P Profile`**.
4. **Precision Time Protocol** > **Configure Clock Parameters** > : set **Slave Only** to **`Yes`**.
5. **Configure Time Source** > : set **Primary Time Source** to **`IEEE1588`**.

Q: How do I configure an End to End (E2E) master clock?

A: Using the ROS menu interface, complete the following steps in order. Each step begins at **Administration** > **System Time Manager**:

1. **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Enable** to **`Yes`**.
2. **Precision Time Protocol** > **Configure Global Parameters**: set **Clock Type****`Ordinary Clock`**.

3. **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Profile** to **`Default E2E Profile`**.
4. **Precision Time Protocol** > **Configure Clock Parameters**: set **Priority1** to **`1`**.
5. **Configure Time Source**: set **Primary Time Source** to your primary time source, such as **`IRIGB`**, **`LOCAL_CLK`**, or **`NTP`**.

Q: How do I configure an E2E slave clock?

A: Using the ROS menu interface, complete the following steps in order. Each step begins at **Administration** > **System Time Manager**:

1. **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Enable** **`Yes`**.
2. **Precision Time Protocol** > **Configure Global Parameters**: set **Clock Type** **`Ordinary Clock`**.
3. **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Profile** **`Default E2E Profile`**.
4. **Configure Time Source**: set **Primary Time Source** **`IEEE1588`**.

Q: How do I configure an IEEE1588 ordinary clock with an IRIG-B time source and power profile?

A: Using the ROS menu interface, complete the following steps in order.

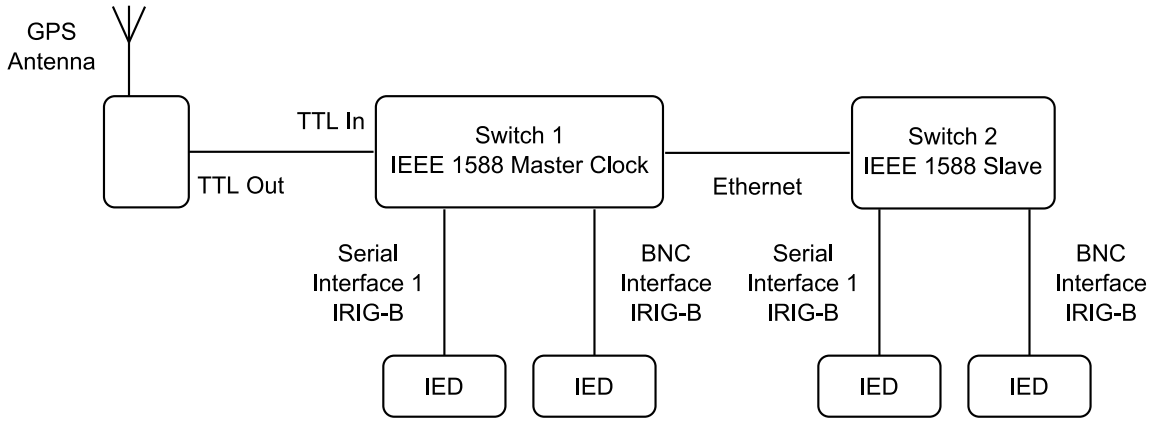


Figure 38: IEEE1588 Ordinary Clock with IRIG-B Time Source and Power Profile

Configuring the Master Clock:

1. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Enable** to **`Yes`**.
2. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **Clock Type** to **`Ordinary Clock`**.
3. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Profile** to **`Power Profile`**.
4. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **Network Class** to **`IEEE1588 Network`**.

5. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **Grandmaster ID** to `100`.
6. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Clock Parameters**: set **Priority 1** to `1`.
7. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Time Source**: set **Primary Time Source** to `IRIGB`.
8. **Serial Protocols** > **Configure Serial Ports**: set **IRIGB** to `PWM` on serial port 1.
9. **Administration** > **System Time Manager** > **Configure IRIGB**: set **IEEE1344** to `Yes`.
10. **Administration** > **System Time Manager** > **View Time Sync Status**, view the IRIGB status on the switch. **Time Source** must equal **IRIGB** and **IRIGB Status** must equal **Lock**.
11. **Administration** > **System Time Manager** > **Precision Time Protocol** > **View PTP Statistics** > **View PTP Clock Stats**, view the IEEE 1588 status on the switch. **Status** must equal **Master**.

Configuring the Slave Clock:

1. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Enable** to `Yes`.
2. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **Clock Type** to `Ordinary Clock`.
3. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **PTP Profile** to `Power Profile`.
4. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Global Parameters**: set **Network Class** to `IEEE1588 Network`.
5. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Clock Parameters**: set **Slave Only** to `Yes`.
6. **Administration** > **System Time Manager** > **Precision Time Protocol** > **Configure Time Source**: set **Primary Time Source** to `IEEE1588`.
7. **Serial Protocols** > **Configure Serial Ports**: set **IRIGB** to `PWM` on serial port 1.
8. **Administration** > **System Time Manager** > **Configure IRIGB**: set **IEEE1344** to `Yes`.
9. **Administration** > **System Time Manager** > **Precision Time Protocol** > **View PTP Statistics** > **View PTP Clock Stats**, view the IEEE 1588 status on the switch. **Status** must equal **Slave**.

Q: Can I configure the RS416 as a transparent clock?

A: No, the RS416 only supports ordinary clock mode.

Q: Can I configure the RS416 as a boundary clock?

A: No, the RS416 only supports ordinary clock mode.

Q: Can I use UDP/IP transport for PTP on the RS416?

A: No, the RS416 only supports PTP over layer 2 (Ethernet) transport.

Q: What is the accuracy of the RS416?

A: Clock accuracy depends on a number of factors, such as the number of hops between master and slave clocks, the stability of the master clock, and the variation in temperature. Normally, an RS416 can achieve an accuracy of 100 microseconds.

Q: How do I upgrade the PTP Firmware?

A: Core PTP functions are implemented in an FPGA on-board the RS416. The FPGA firmware is field upgradeable via the ROS file: `fpga416.xsvf` . Please refer to Section 15.4, “Upgrading Firmware” for details on upgrading ROS firmware files.

Q: How do I configure an IRIG-B Slave?

A: Using the ROS menu interface, complete the following steps in order. Each step begins at Administration → System Time Manager:

1. **Configure Time Source**: set **Primary Time Source** to **`IRIGB`**.
2. **Configure Time and Date**: set **Time Zone**.
3. **Configure Time and Date**: set **DST Offset**.
4. **Configure Time and Date**: set **DST Rule**.
5. **Configure IRIGB**: set **IEEE 1344** to **`Yes`**.

Q: How do I configure an IEEE1588 ordinary clock with a GPS time source and layer 3 end-to-end?

A: The following describes how to configure a master and slave clock with a GPS and IEEE1588 time source, and layer 3 multicast. Using the ROS menu interface, do the following:

NOTE
Each step begins at Administration > System Time Manager.

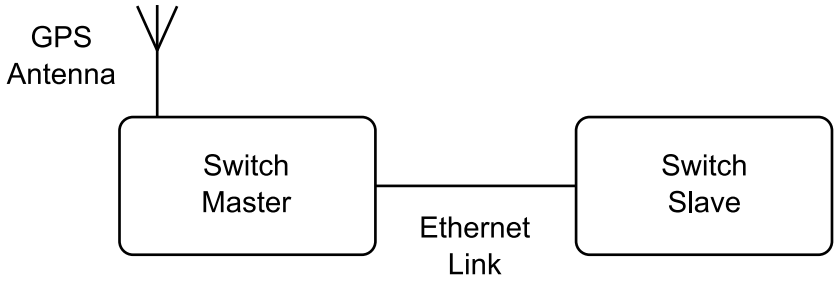


Figure 39: Ordinary Clock with a GPS Time Source and Layer 3 End-to-End

Procedure: Configuring the master clock

1. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Enable** to **`Yes`**.
2. Under **Precision Time Control** > **Configure Global Parameters**, set **Clock Type** to **`Ordinary Clock`**.
3. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Profile** to **`Custom Profile`**.

4. Under **Precision Time Control** > **Configure Global Parameters**, set **Transport Protocol** to **`Layer 3 Multicast`**.
5. Under **Precision Time Control** > **Configure Global Parameters**, set **Network Class** to **`IEEE1588 Network`**.
6. Under **Precision Time Control** > **Configure Clock Parameters**, set **Priority1** to **`1`**
7. Under **Precision Time Control** > **Configure Time Source**, set **Primary Time Source** to **`GPS`**.
8. Under **View Time Sync Status**, view the GPS status on the switch. **Time Source** must equal **GPS** and **GPS Status** must equal **Lock**.
9. Under **Precision Time Control** > **View PTP Statistics** > **View PTP Clock Stats**, view the IEEE1588 status on the switch. **Status** must equal **Master**.

Procedure: Configure the slave clock

1. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Enable** to **`Yes`**.
2. Under **Precision Time Control** > **Configure Global Parameters**, set **Clock Type** to **`Ordinary Clock`**.
3. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Profile** to **`Custom Profile`**.
4. Under **Precision Time Control** > **Configure Global Parameters**, set **Transport Protocol** to **`Layer 3 Multicast`**.
5. Under **Precision Time Control** > **Configure Global Parameters**, set **Network Class** to **`IEEE1588 Network`**.
6. Under **Precision Time Control** > **Configure Clock Parameters**, set **Slave Only** to **`Yes`**
7. Under **Precision Time Control** > **Configure Time Source**, set **Primary Time Source** to **`IEEE1588`**.
8. Under **Precision Time Control** > **View PTP Statistics** > **View PTP Clock Stats**, view the IEEE1588 status on the switch. **Status** must equal **Slave**.

Q: How do I configure an IEEE1588 ordinary clock and transparent clock with a GPS time source and power profile?

A: The following describes how to configure a master clock, transparent clock and slave with a GPS time source and power profile. Using the ROS menu interface, do the following:

NOTE
Each step begins at Administration > System Time Manager.

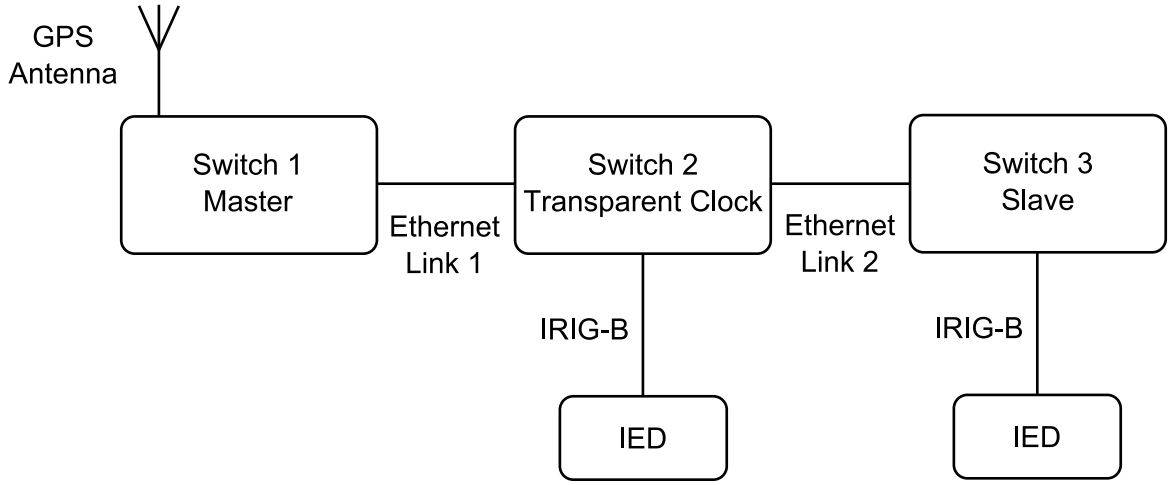


Figure 40: Ordinary Clock and Transparent Clock with a GPS Time Source and Power Profile

Procedure: Configuring the master clock

1. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Enable** to **`Yes`**.
2. Under **Precision Time Control** > **Configure Global Parameters**, set **Clock Type** to **`Ordinary Clock`**.
3. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Profile** to **`Power Profile`**.
4. Under **Precision Time Control** > **Configure Global Parameters**, set **Grandmaster ID** to **`100`**.
5. Under **Precision Time Control** > **Configure Global Parameters**, set **Network Class** to **`IEEE1588 Network`**.
6. Under **Precision Time Control** > **Configure Clock Parameters**, set **Priority1** to **`1`**.
7. Under **Configure Time Source**, set **Primary Time Source** to **`GPS`**.
8. Under **View Time Sync Status**, view the GPS status on the switch. **Time Source** must equal **GPS** and **GPS Status** must equal **Lock**
9. Under **Precision Time Control** > **View PTP Statistics** > **View PTP Clock Stats**, view the IEEE1588 status on the switch. **Status** must equal **Master**.
10. Configure IRIG-B as the time source for all Intelligent Electronic Devices (IEDs). For more information, see Section 2.11.5, “Configuring IRIG-B”.

Procedure: Configuring the transparent clock

1. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Enable** to **`Yes`**.
2. Under **Precision Time Control** > **Configure Global Parameters**, set **Clock Type** to **`OC and PTP TClock`**.
3. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Profile** to **`Power Profile`**.
4. Under **Precision Time Control** > **Configure Global Parameters**, set **Network Class** to **`IEEE1588 Network`**.
5. Under **Precision Time Control** > **Configure Clock Parameters**, set **Slave Only** to **`Yes`**.

6. Under **Configure Time Source**, set **Primary Time Source** to **`IEEE1588`**.
7. Under **Configure IRIGB**, set **IEEE1344** to **`Yes`**.

Procedure: Configuring the slave clock

1. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Enable** to **`Yes`**.
2. Under **Precision Time Control** > **Configure Global Parameters**, set **Clock Type** to **`Ordinary Clock`**.
3. Under **Precision Time Control** > **Configure Global Parameters**, set **PTP Profile** to **`Power Profile`**.
4. Under **Precision Time Control** > **Configure Global Parameters**, set **Network Class** to **`IEEE1588 Network`**.
5. Under **Precision Time Control** > **Configure Clock Parameters**, set **Slave Only** to **`Yes`**.
6. Under **Configure Time Source**, set **Primary Time Source** to **`IEEE1588`**.
7. Under **Configure IRIGB**, set **IEEE1344** to **`Yes`**.

Q: IEEE1588 Firmware Dependencies

A: The following table shows the dependencies between ROS and FPGA firmware revisions and new features introduced during relevant releases.

Table: ROS and FPGA416 Firmware Dependencies

ROS Version	FPGA416 Version	Feature Introduced
ROS 3.11	FGPA416 128	IRIG-B cable compensation IEEE1344 extension
ROS 3.10	FPGA416 120	
ROS 3.9	FPGA416 120	PTP profiles
ROS 3.8	FPGA416 120	IEEE1588
ROS 3.7	FPGA416 102	IRIGB

Section 2.12
SNMP Management

ROS supports Simple Network Management Protocol Versions 1 (SNMPv1), 2 (SNMPv2c), and 3 (SNMPv3). SNMPv3 protocol provides secure access to devices by a combination of authentication and packet encryption over the network. SNMPv3 security features include the following:

- message integrity – ensures that a packet has not been tampered with in-transit.
- authentication – determines the message is from a valid source.
- encryption – scrambles the contents of a packet to prevent it from being seen by an unauthorized source.

SNMPv3 provides security models and security levels. A security model is an authentication strategy that is set up for a user and the group in which the user resides. A security level is a permitted level of security within a security model. A combination of a security model and security level will determine which security mechanism is employed when handling an SNMP packet.

Note the following about the SNMPv3 protocol:

- each user belongs to a group.
- a group defines the access policy for a set of users.
- an access policy defines what SNMP objects can be accessed for: reading, writing and creating notifications.
- a group determines the list of notifications its users can receive.
- a group also defines the security model and security level for its users.

Community is configured for protocols v1 and v2c. Community is mapped to the group and access level with security name (which is configured as User name).

Section 2.12.1

SNMP Users

These parameters provide the ability to configure users for the local SNMPv3 engine, along with the community for SNMPv1 and SNMPv2c. Note that when employing the SNMPv1 or SNMPv2c security level, the User Name maps the community name with the security group and access level. Up to 32 entries can be configured.

WARNING!

When creating a new auth or priv key, make sure it adheres to the following rules:

- *Must not be less than 6 characters in length.*
- *Must not include the username or any 4 continous alphanumeric characters found in the username. For example, if the username is Subnet25, the password may not be subnet25admin or subnetadmin. However, net25admin or Sub25admin is permitted.*
- *Must have at least one alphabetic character and one number. Special characters are permitted.*
- *Must not have more than 3 continuously incrementing or decrementing numbers. For example, Sub123 and Sub19826 are permitted, but Sub12345 is not.*

An alarm will generate if a weak password is configured. The weak password alarm can be disabled by user. For more information about disabling alarms, refer to Section 14.1.4, "Configuring Alarms".

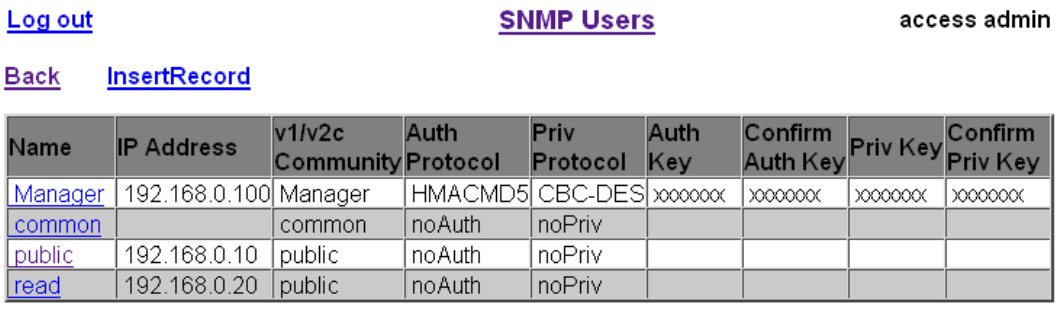


Figure 41: SNMP User Table

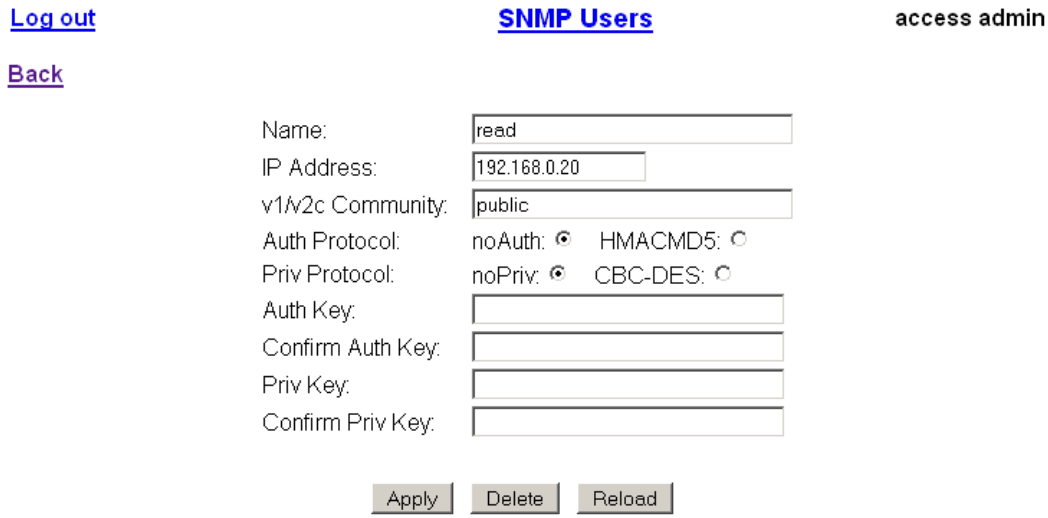


Figure 42: SNMP User Form

Parameter	Description
Name	**Synopsis:** Any 32 characters **Default:** initial The name of the user. This user name also represents the security name that maps this user to the security group.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 **Default:** The IP address of the user's SNMP management station. If IP address is configured, SNMP requests from that user will be verified by IP address as well. SNMP Authentication trap will be generated to trap receivers if request was received from this user, but from any other IP address. If IP address is empty, traps can not be generated to this user, but SNMP requests will be served for this user from any IP address.
v1/v2c Community	**Synopsis:** Any 32 characters **Default:** The community string which is mapped by this user/security name to the security group if security model is SNMPv1 or SNMPv2c. If this string is left empty, it will be assumed to be equal to the same as user name.
Auth Protocol	**Synopsis:** { noAuth, HMACMD5 } **Default:** noAuth An indication of whether messages sent on behalf of this user to/from SNMP engine, can be authenticated, and if so, the type of authentication protocol which is used.
Priv Protocol	**Synopsis:** { noPriv, CBC-DES } **Default:** noPriv An indication of whether messages sent on behalf of this user to/from SNMP engine can be protected from disclosure, and if so, the type of privacy protocol which is used.
Auth Key	**Synopsis:** 31 character ASCII string **Default:** The secret authentication key (password) that must be shared with SNMP client. if the key is not an emtpy string, it must be at least 6 characters long.
Confirm Auth Key	**Synopsis:** 31 character ASCII string **Default:**

Parameter	Description
	The secret authentication key (password) that must be shared with SNMP client. if the key is not an emtpy string, it must be at least 6 characters long.
Priv Key	**Synopsis:** 31 character ASCII string **Default:** The secret encryption key (password) that must be shared with SNMP client. If the key is not an emtpy string, it must be at least 6 characters long.
Confirm Priv Key	**Synopsis:** 31 character ASCII string **Default:** The secret encription key (password) that must be shared with SNMP client. if the ke is not an emtpy string, it must be at least 6 characters long.

Section 2.12.2

SNMP Security to Group Maps

Entries in this table map configuration of security model and security name (user) into a group name, which is used to define an access control policy. Up to 32 entries can be configured.

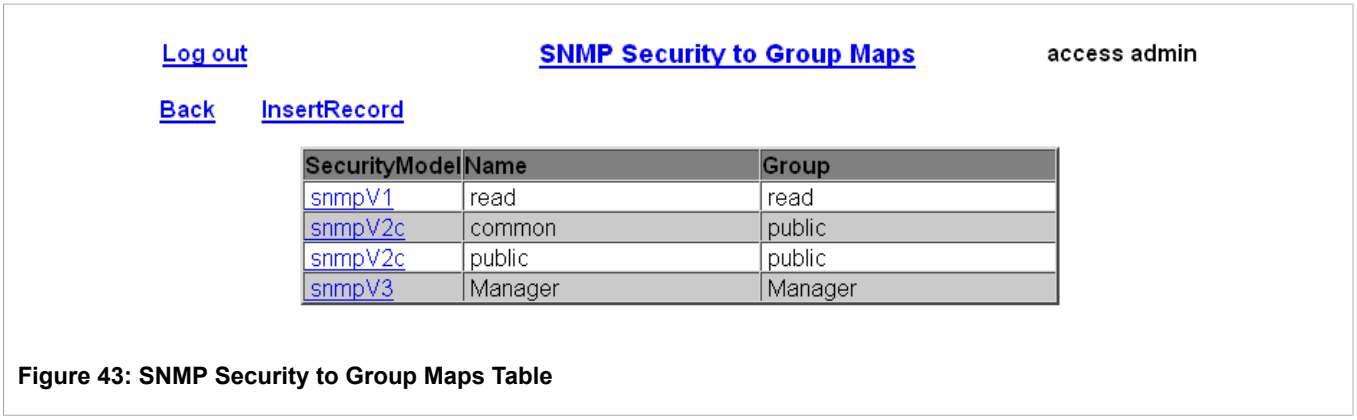


Figure 43: SNMP Security to Group Maps Table

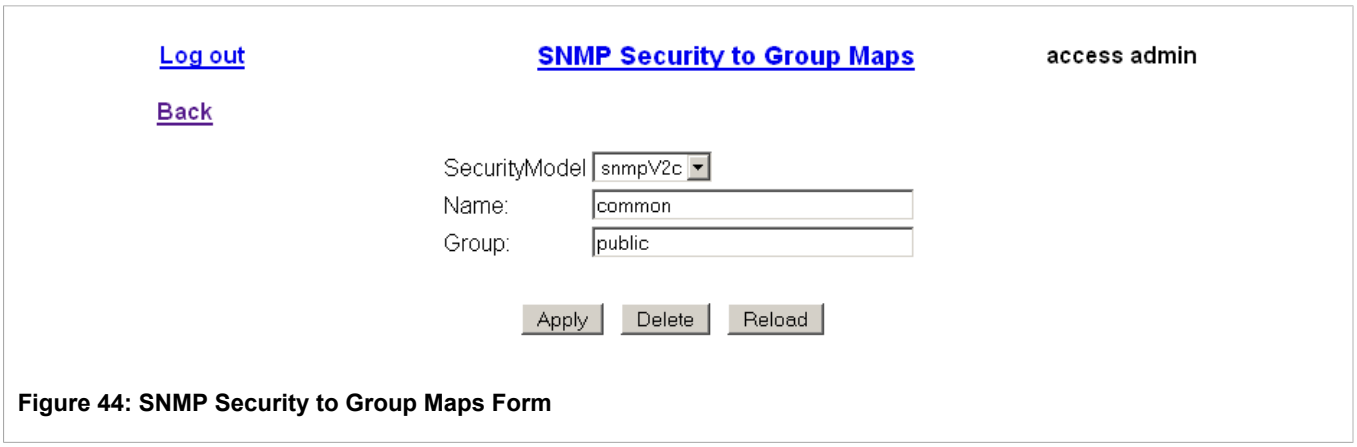


Figure 44: SNMP Security to Group Maps Form

Parameter	Description
SecurityModel	**Synopsis:** { snmpV1, snmpV2c, snmpV3 } **Default:** snmpV3 The Security Model that provides the name referenced in this table.

Parameter	Description
Name	**Synopsis:** Any 32 characters Default: The user name which is mapped by this entry to the specified group name.
Group	**Synopsis:** Any 32 characters Default: The group name to which the security model and name belong. This name is used as an index to the SNMPv3 VACM Access Table.

Section 2.12.3
SNMP Access

These parameters provide the ability to configure access rights for groups.To determine whether access is allowed, one entry from this table needs to be selected and the proper view name from that entry must be used for access control checking. View names are predefined:

- noView - access is not allowed
- V1Mib - SNMPv3 MIBs excluded
- allOfMibs - all supported MIBs are included.

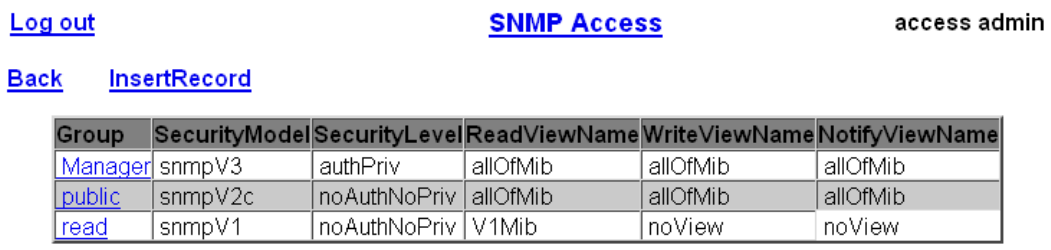


Figure 45: SNMP Access Table

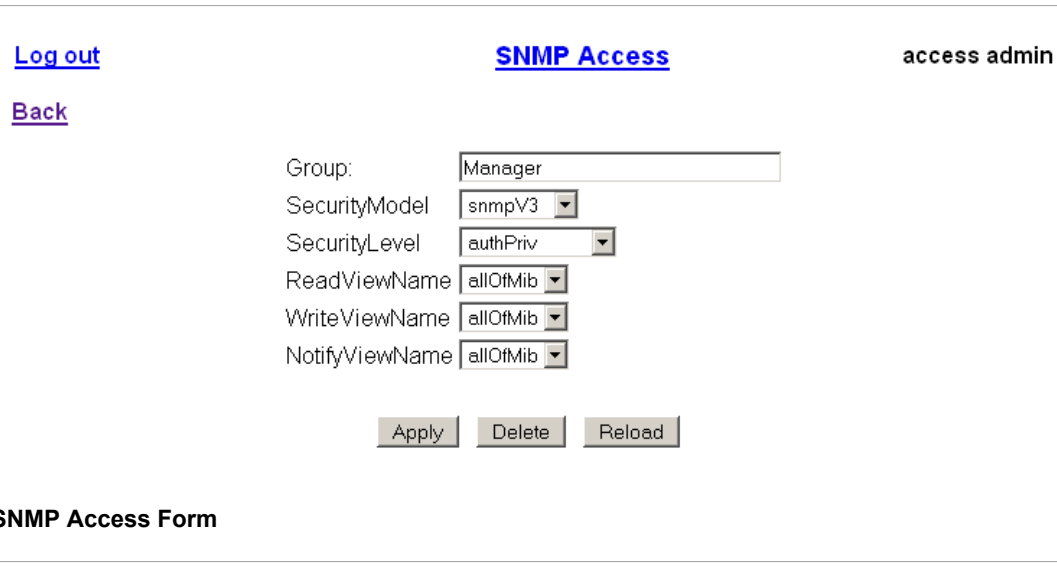


Figure 46: SNMP Access Form

Parameter	Description
Group	**Synopsis:** Any 32 characters Default: The group name to which the security model and name belong. This name is used as an index to the SNMPv3 VACM Access Table.
SecurityModel	**Synopsis:** { snmpV1, snmpV2c, snmpV3 } **Default:** snmpV3 In order to gain the access rights allowed by this entry, the configured security model must be in use.
SecurityLevel	**Synopsis:** { noAuthNoPriv, authNoPriv, authPriv } **Default:** noAuthNoPriv The minimum level of security required in order to gain the access rights allowed by this entry. A security level of noAuthNoPriv is less than authNoPriv, which is less than authPriv.
ReadViewName	**Synopsis:** { noView, V1Mib, allOfMib } **Default:** noView This parameter identifies the MIB tree(s) to which this entry authorizes read access. If the value is noView, then read access will not be granted.
WriteViewName	**Synopsis:** { noView, V1Mib, allOfMib } **Default:** noView This parameter identifies the MIB tree(s) to which this entry authorizes write access. If the value is noView, then write access will not be granted.
NotifyViewName	**Synopsis:** { noView, V1Mib, allOfMib } **Default:** noView This parameter identifies the MIB tree(s) to which this entry authorizes access for notifications. If the value is noView, then access for notifications will not be granted.

Section 2.13
RADIUS

RADIUS (Remote Authentication Dial In User Service) is used to provide centralized authentication and authorization for network access. ROS assigns a privilege level of Admin, Operator or Guest to a user who presents a valid user name and password. The number of users who can access the ROS server is ordinarily dependent on the number of user records which can be configured on the server itself. ROS can also, however, be configured to pass along the credentials provided by the user to be remotely authenticated by a RADIUS server. In this way, a single RADIUS server can centrally store user data and provide authentication and authorization service to multiple ROS servers needing to authenticate connection attempts.

Section 2.13.1
RADIUS overview

RADIUS (described in RFC 2865 [http://tools.ietf.org/html/rfc2865]) is a UDP-based protocol used for carrying authentication, authorization, and configuration information between a Network Access Server which desires to authenticate its links and a shared Authentication Server. RADIUS is also widely used in conjunction with 802.1x for port security using EAP (the Extensible Authentication Protocol, described in RFC 3748 [http://tools.ietf.org/html/rfc3748]). For Port Security configuration details, see Chapter 9, *Port Security*.

A RADIUS server can act as a proxy client to other RADIUS servers or other kinds of authentication servers.

Unlike TACACS+, authorization and authentication functionality is supported by RADIUS in the same packet frame. TACACS+ actually separates authentication from authorization into separate packets.

On receiving an authentication-authorization request from a client in an “Access-Request” packet, the RADIUS server checks the conditions configured for received username-password combination in the user database. If all the conditions are met, the list of configuration values for the user is placed into an “Access-Accept” packet. These values include the type of service (e.g. SLIP, PPP, Login User) and all the necessary values to deliver the desired service.

Section 2.13.2

User Login Authentication and Authorization

A RADIUS server can be used to authenticate and authorize access to the device's services, such as HMI via Serial Console, Telnet, SSH, RSH, Web Server (see Password Configuration). ROS implements a RADIUS client which uses the Password Authentication Protocol (PAP) to verify access. Attributes sent to a RADIUS server are:

- user name
- user password
- service type: Login
- vendor specific, currently defined as the following:

  vendor ID: Siemens AG enterprise number (15004) assigned by the Internet Assigned Numbers Authority (IANA)

  string, sub-attribute containing specific values:

  subtype: 1 (vendor's name subtype)

  length: 11 (total length of sub-attribute of subtype 1)

  ASCII string “RuggedCom”

Two RADIUS servers (Primary and Secondary) are configurable per device. If the Primary Server is not reachable, the device will automatically fall back to the Secondary server to complete the authorization process.

The vendor specific attribute is used to determine the access level from the server, which may be configured at the RADIUS server with the following information:

- Vendor ID: Siemens AG enterprise number (15004) assigned by Internet Assigned Numbers Authority (IANA)
- Sub-attribute Format: String
- Vendor Assigned Sub-Attribute Number: 2
- Attribute value – any one of: admin, operator, guest

NOTE
If no access level is received in the response packet from the server then no access will be granted to the user

An Example of a RUGGEDCOM Dictionary for a FreeRADIUS server:

VENDOR	RuggedCom 15004
BEGIN-VENDOR	RuggedCom
ATTRIBUTE	RuggedCom-Privilege-level 2 string
END-VENDOR	RuggedCom

Sample entry for user “admin” Adding Users:

admin Auth-Type := Local, User-Password == “admin”

RuggedCom-Privilege-level = “admin”

Section 2.13.3

802.1X Authentication

A RADIUS server may also be used to authenticate access on ports with 802.1X security support. Attributes sent to the RADIUS server in a RADIUS Request are:

- user name, derived from client's EAP identity response
- NAS IP address
- service type: framed
- framed MTU:1500 (maximum size of EAP frame, which is the size of an Ethernet frame)
- EAP message
- vendor specific attribute, as described above

RADIUS messages are sent as UDP messages. The switch and the RADIUS server must use the same authentication and encryption key.

NOTE
ROS supports both PEAP and EAP-MD5. PEAP is more secure and is recommended if available in the supplicant.

Section 2.13.4

RADIUS Server Configuration

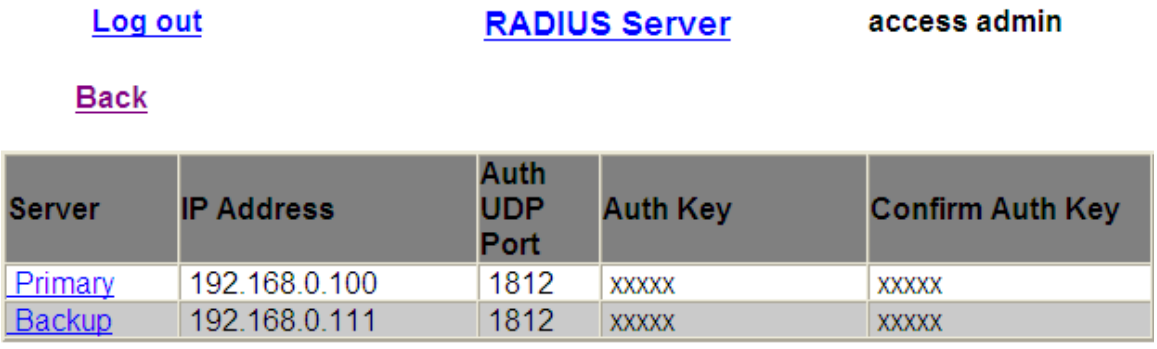


Figure 47: RADIUS Server Summary

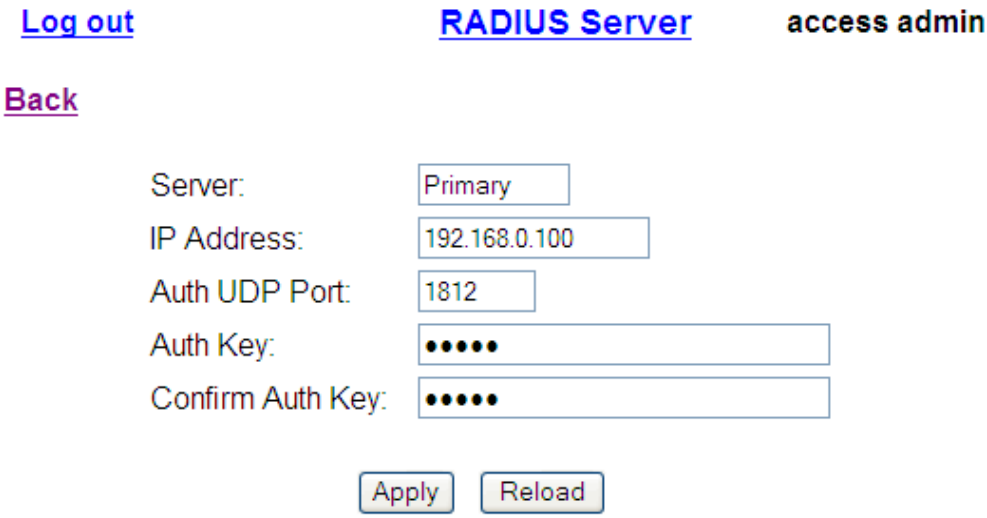


Figure 48: RADIUS Server Form

Parameter	Description
Server	**Synopsis:** Any 8 characters **Default:** Primary This field tells whether this configuration is for a primary or a backup server
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 Default: The RADIUS server IP Address.
Auth UDP Port	**Synopsis:** 1 to 65535 **Default:** 1812 The authentication UDP Port on the RADIUS server.
Auth Key	**Synopsis:** 31 character ASCII string **Default:** None The authentication key shared with the RADIUS server. It is used to encrypt any passwords that are sent between the switch and the RADIUS server.
Confirm Auth Key	**Synopsis:** 31 character ASCII string **Default:** None Confirm input of the above authentication key.

Section 2.14

TACACS+

TACACS+ (Terminal Access Controller Access-Control System Plus) is a TCP-based access control protocol that provides authentication, authorization and accounting services to routers, network access servers and other networked computing devices via one or more centralized servers. It is based on, but is not compatible with, the older TACACS protocol. TACACS+ has generally replaced its predecessor in more recently built or updated networks, although TACACS and XTACACS are still used on many older networks. Note that Siemens' TACACS+ client implementation always has encryption enabled.

Section 2.14.1

User Login Authentication and Authorization

A TACACS+ server can be used to authenticate and authorize access to the device's services, such as HMI via Serial Console, Telnet, SSH, RSH, Web Server (see Password Configuration). User name and Password are sent to the configured TACACS+ Server.

Two TACACS+ servers (Primary and Secondary) are configurable per device. If the primary server is not reachable, the device will automatically fall back to the secondary server to complete the authorization process.

Section 2.14.2

TACACS+ Server Configuration

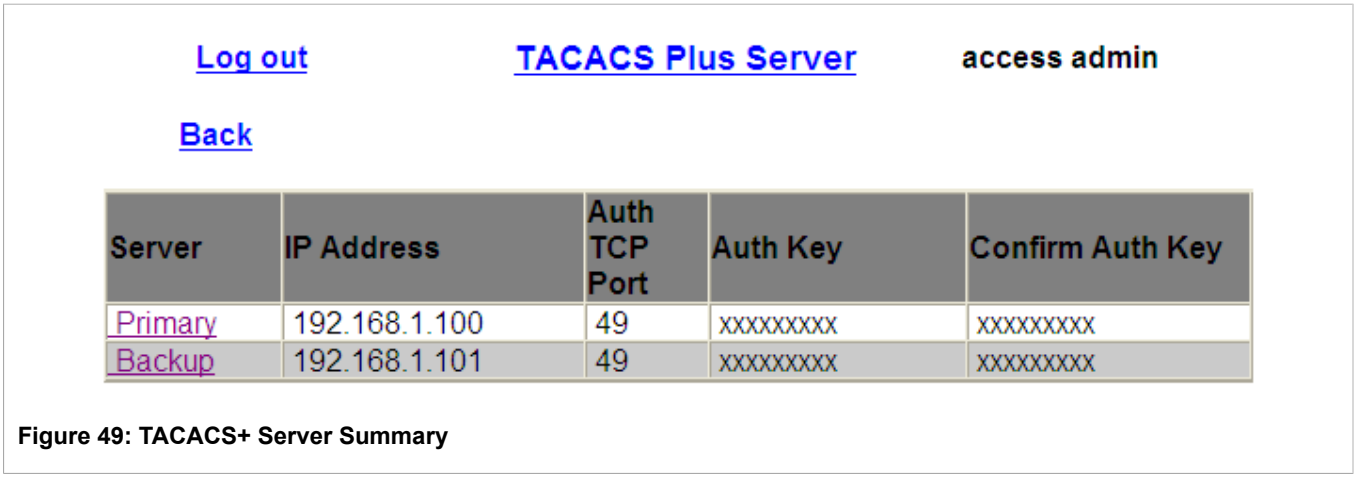


Figure 49: TACACS+ Server Summary

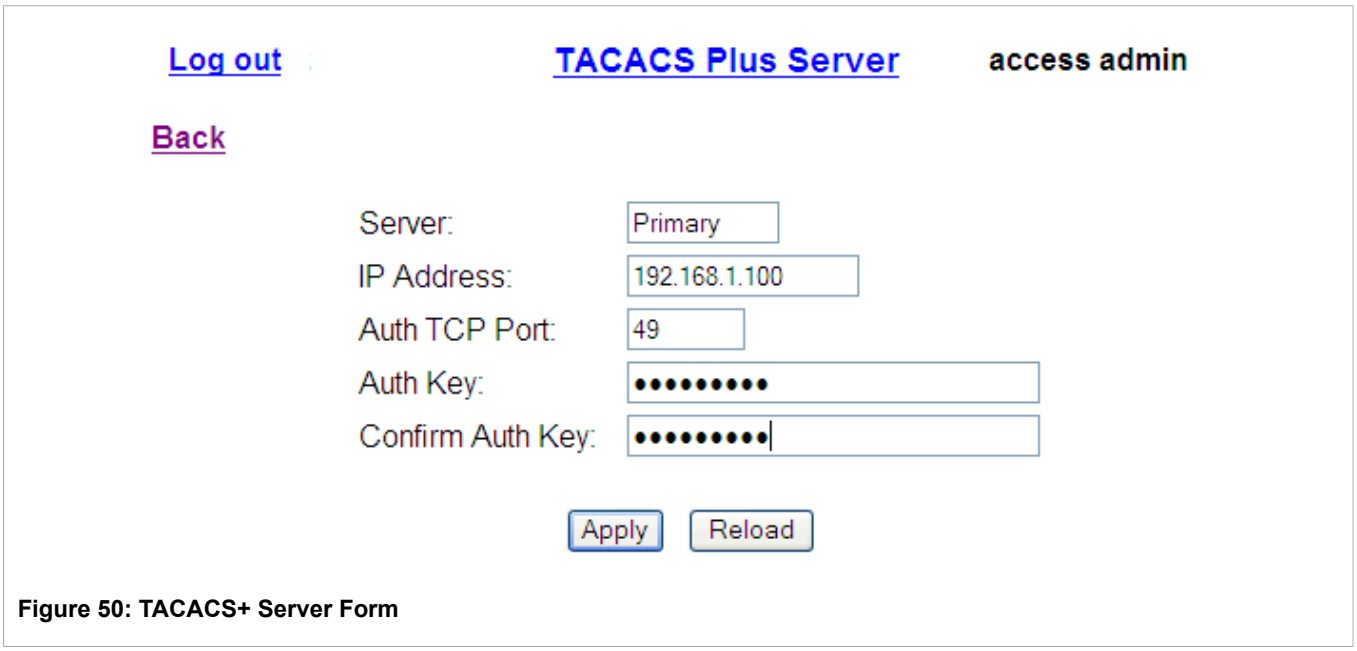


Figure 50: TACACS+ Server Form

Parameter	Description
Server	**Synopsis:** Any 8 characters

Parameter	Description
	Default: Primary This field indicates whether this configuration is for a primary or a backup server.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 Default: The TACACS+ server IP Address.
Auth TCP Port	**Synopsis:** 1 to 65535 **Default:** 49 The authentication TCP Port on the TACACS+ server.
Auth Key	**Synopsis:** 31 character ASCII string Default: The authentication key shared with the TACACS+ server. It is used to encrypt any passwords that are sent from the switch to the TACACS+ server.
Confirm Auth Key	**Synopsis:** 31 character ASCII string **Default:** None Confirm input of the above authentication key.

Section 2.14.3
User Privilege Level Configuration

The TACACS+ standard priv_lvl attribute is used to grant access to the device. By default, the attribute uses the following ranges:

- **`priv_lvl=15`** represents an access level of “admin”
- **`1 < priv_lvl < 15`** (any value from 2 to 14) represents an access level of “operator”
- **`priv_lvl=1`** represents an access level of “guest”

You can also configure a different non-default access level for admin, operator or guest users.

NOTE
If an access level is not received in the response packet from the server, access is not be granted to the user.

Section 2.14.4
TACACS+ Server Privilege Configuration

Figure 51: TACACS+ Server Privilege Form

Parameter	Description
Admin Priv	**Synopsis:** (0 to 15)-(0 to 15) **Default:** 15 Privilege level to be assigned to the user.
Oper Priv	**Synopsis:** (0 to 15)-(0 to 15) **Default:** 2-14 Privilege level to be assigned to the user.
Guest Priv	**Synopsis:** (0 to 15)-(0 to 15) **Default:** 1 Privilege level to be assigned to the user.

Section 2.15
DHCP Relay Agent

A DHCP Relay Agent is a device that forwards DHCP packets between clients and servers when they are not on the same physical LAN segment or IP subnet. The feature is enabled if the DHCP server IP address and a set of access ports are configured.

DHCP Option 82 provides a mechanism for assigning an IP Address based on the location of the client device in the network. Information about the client's location can be sent along with the DHCP request to the server. The DHCP server makes a decision about an IP Address to be assigned, based on this information.

DHCP Relay Agent takes the broadcast DHCP requests from clients received on the configured access port and inserts the relay agent information option (Option 82) into the packet. Option 82 contains the VLAN ID (2 bytes) and the port number of the access port (2 bytes - the circuit ID sub-option) and the switch's MAC address (the remote ID sub-option). This information uniquely defines the access port's position in the network.

The DHCP Server supporting DHCP option 82 sends a unicast reply and echoes Option 82. The DHCP Relay Agent removes the Option 82 field and broadcasts the packet to the port from which the original request was received.

These parameters provide the ability to configure the switch to act as a relay agent for DHCP Option 82.

The DHCP Relay Agent is communicating to the server on a management interface. The agent's IP address is the address configured for the management interface.

Figure 52: DHCP Relay Agent Form

Parameter	Description
DHCP Server Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 Default: This parameter specifies the IP address of the DHCP server to which DHCP queries will be forwarded from this relay agent.
DHCP Client Ports	**Synopsis:** Any combination of numbers valid for this parameter **Default:** None This parameter specifies ports where DHCP clients are connected. **Examples:** • *All* - all ports of the switch can have DHCP clients connected. • *2,4-6,8* - ports 2,4,5,6 and 8 can have DHCP clients connected.

Section 2.16

Syslog

The syslog provides users with the ability to configure local and remote syslog connections. The remote syslog protocol, defined in RFC 3164, is a UDP/IP-based transport that enables a device to send event notification messages across IP networks to event message collectors, also known as syslog servers. The protocol is simply designed to transport these event messages from the generating device to the collector.

CAUTION!
Remote syslog, while a powerful utility for network monitoring, is not a secure service. Information sent to a remote syslog server is delivered in plaintext.

The syslog client resides in ROS and supports up to 5 collectors (syslog servers). ROS Remote Syslog provides the ability to configure:

- IP address(es) of collector(s).
- Source UDP port.
- Destination UDP port per collector.
- Syslog source facility ID per collector (same value for all ROS modules).

- Filtering severity level per collector (in case different collectors are interested in syslog reports with different severity levels).

Section 2.16.1
Configuring Local Syslog

The local syslog configuration enables users to control what level of syslog information will be logged. Only messages of a severity level equal to or greater than the configured severity level are written to the syslog.txt file in the unit.

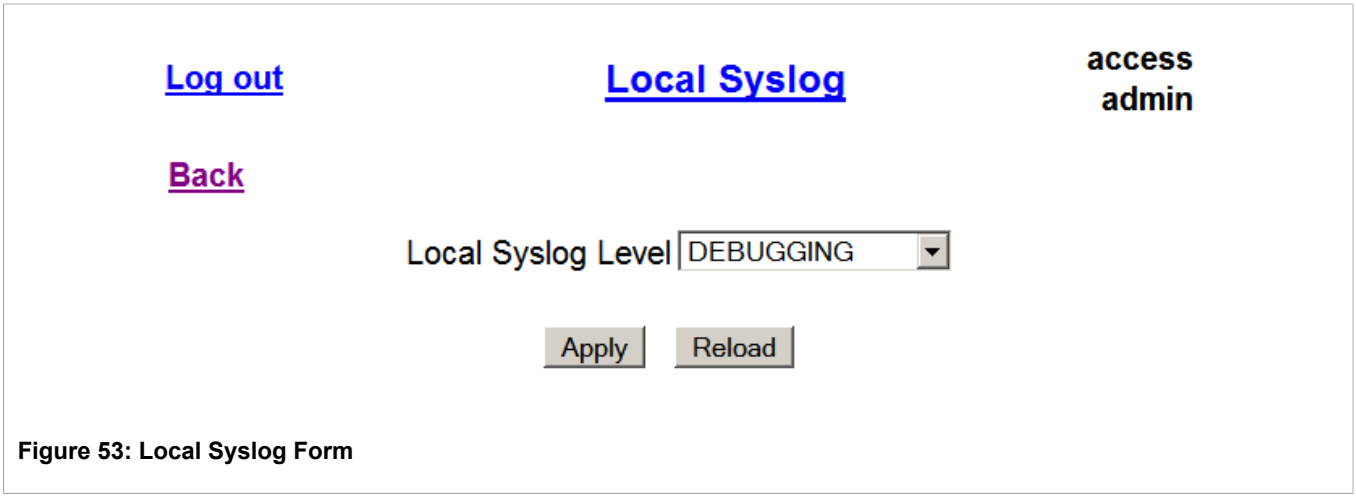


Figure 53: Local Syslog Form

Parameter	Description
Local Syslog Level	**Synopsis:** { EMERGENCY, ALERT, CRITICAL, ERROR, WARNING, NOTICE, INFORMATIONAL, DEBUGGING } **Default:** INFORMATIONAL The severity of the message that has been generated. Note that the severity level selected is considered the minimum severity level for the system. For example, if ERROR is selected, the system sends any syslog messages generated by Error, Critical, Alert and Emergency.

Section 2.16.2
Configuring Remote Syslog Client

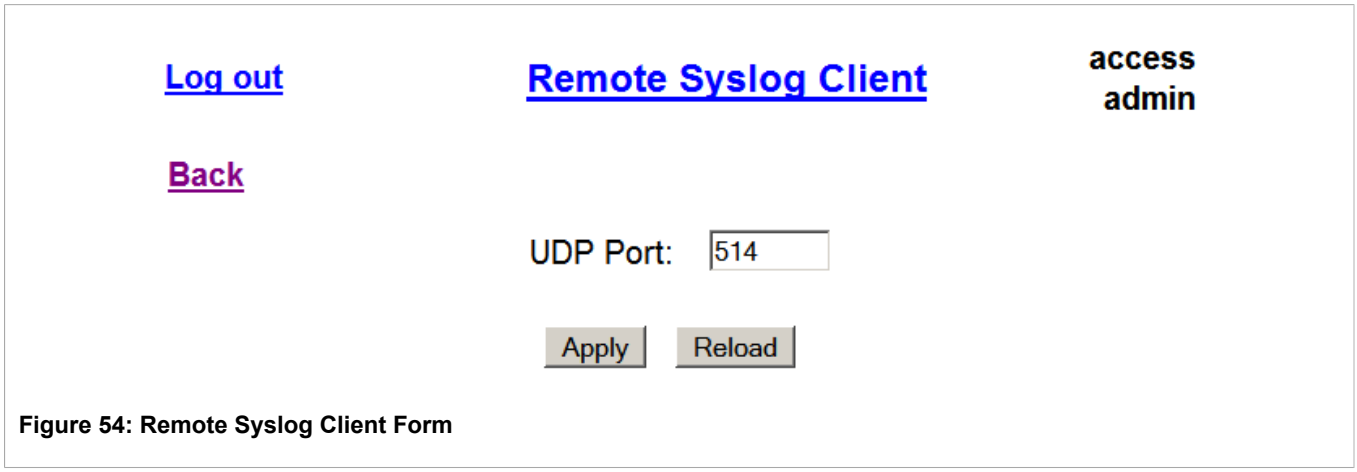


Figure 54: Remote Syslog Client Form

Parameter	Description
UDP Port	**Synopsis:** 1025 to 65535 or { 514 } **Default:** 514 The local UDP port through which the client sends information to the server(s).

Section 2.16.3
Configuring the Remote Syslog Server

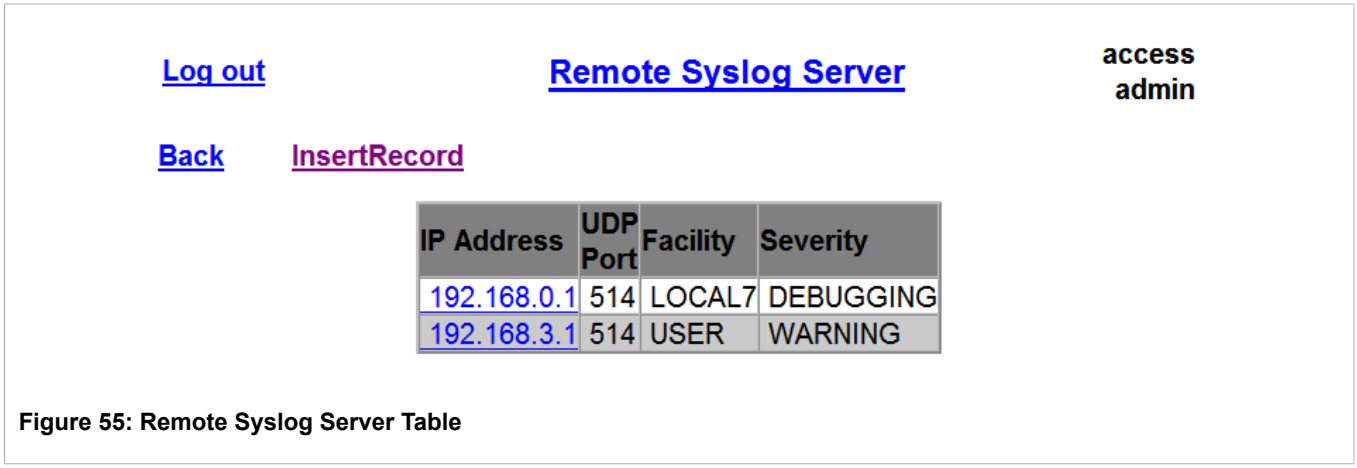


Figure 55: Remote Syslog Server Table

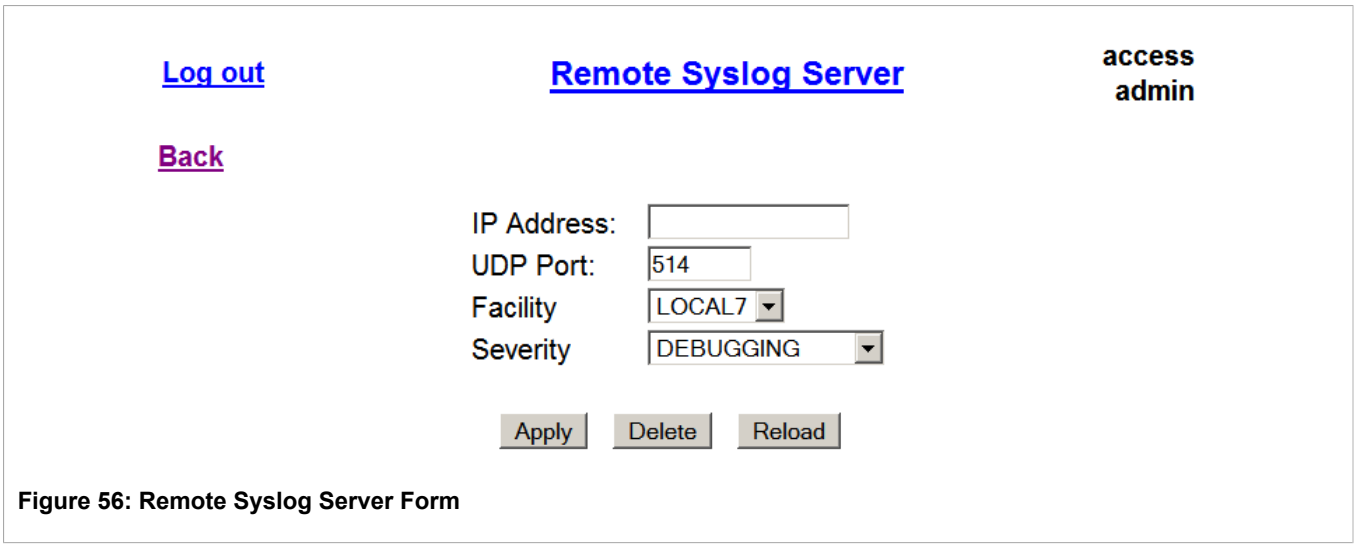


Figure 56: Remote Syslog Server Form

Parameter	Description
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 Default: Syslog server IP Address.
UDP Port	**Synopsis:** 1025 to 65535 or { 514 } **Default:** 514 The UDP port number on which the remote server listens.
Facility	**Synopsis:** { USER, LOCAL0, LOCAL1, LOCAL2, LOCAL3, LOCAL4, LOCAL5, LOCAL6, LOCAL7 } **Default:** LOCAL7 Syslog facility name - { USER, LOCAL0, LOCAL1, LOCAL2, LOCAL3, LOCAL4, LOCAL5, LOCAL6, LOCAL7 }. Syslog Facility is an information field associated with a syslog message. The syslog facility is the application or operating system component that generates a log message. ROS maps all syslog logging information onto a single facility, which is configurable to facilitate a remote syslog server.
Severity	**Synopsis:** { EMERGENCY, ALERT, CRITICAL, ERROR, WARNING, NOTICE, INFORMATIONAL, DEBUGGING } **Default:** DEBUGGING Syslog severity level - {EMERGENCY, ALERT, CRITICAL, ERROR, WARNING, NOTICE, INFORMATIONAL, DEBUGGING}. The severity level is the severity of the generated message. Note that the selected severity level is accepted as the minimum severity level for the system. For example, if the severity level is set as “Error”, then the system sends any syslog message generated by Error, Critical, Alert and Emergency events.

Section 2.17

Troubleshooting

Problem One

I have configured the IP address and a gateway. I am pinging the switch but it is not responding. I am sure the switch is receiving the ping because its port LEDs are flashing and the statistics menu shows the pings. What is going on?

Is the switch being pinged through a router? If so, the switch gateway address must be configured. The following figure illustrates the problem.

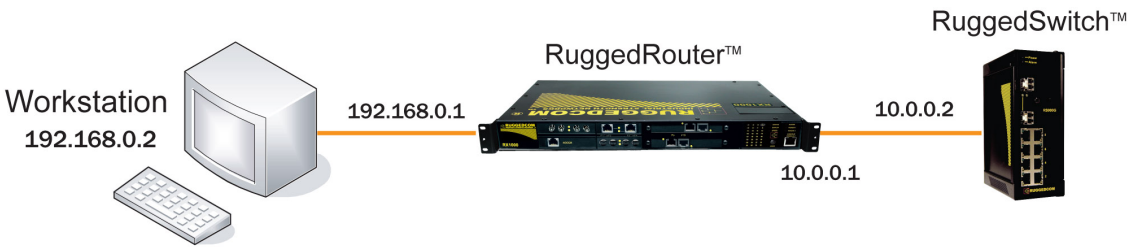


Figure 57: Using A Router As A Gateway

The router is configured with the appropriate IP subnets and will forward the ping from the workstation to the switch. When the switch responds, however, it will not know which of its interfaces to use in order to reach the workstation and will drop the response. Programming a gateway of 10.0.0.1 will cause the switch to forward unresolvable frames to the router.

This problem will also occur if the gateway address is not configured and the switch tries to raise an SNMP trap to a host that is not on the local subnet.

3 Serial Protocols

RUGGEDCOM devices support the following serial protocols:

- Raw Socket serial encapsulation
- Preemptive Raw Socket
- TCPModbus (client and server modes)
- DNP 3
- DNP packetization over Raw Socket
- Microlok
- WIN and TIN
- Mirrored Bits
- TelnetComPort (RFC2217)

Section 3.1
Serial Protocols Overview

Serial interface bit rates can be configured in range of 100 to 230400 bps. A "turnaround" time is supported to enforce minimum times between successive messages transmitted via a serial port.

If a port is set to force half-duplex mode, while sending data, all received data will be discarded. To set this mode, the port must natively work in full-duplex mode.

To transport protocol messages through the network, either TCP/IP or UDP/IP transport can be used. The exception is the TCPModbus protocol, which cannot be employed over UDP.

The setting of Differentiated Services Code Point (DSCP) in the IP header is provided for TCP/IP and UDP/IP transport in the egress direction only.

Debugging facilities include statistics and tracing information on a serial port and/or network transport.

Section 3.1.1
Raw Socket protocol features

- A means to transport streams of characters from one serial port, over an IP network to another serial port.
- XON/XOFF flow control.
- Configurable local and remote IP port numbers per serial port.
- Many-to-many UDP transactions.
- TCP accept or request connection mode.
- Point-to-point TCP connection mode and a broadcast connection mode in which up to 64 remote servers may connect to a central server.
- Packetization and sending data on a specific packet size, a specific character, or upon a timeout.

- Configurable “turnaround” time to enforce minimum time between messages sent out the serial port.

Section 3.1.2
DNP over Raw Socket protocol features

- Packetization and sending data per DNP 3 protocol specification.

Section 3.1.3
Preemptive Raw Socket protocol features

- A means to transport streams of characters from one serial port, over an IP network, to another serial port.
- Configurable local and remote IP port numbers per serial port.
- TCP accept or request one permanent connection on configured IP address.
- TCP accept one dynamic connection from different IP address.
- Dynamic connection activity timer controlled.
- XON/XOFF flow control for permanent connection.
- ‘Packetization’ trigger based on a specific packet size, a specific character, or upon a timeout for each connection.

Section 3.1.4
Modbus protocol features

- Operation in TCPModbus Server Gateway or Client Gateway mod.e
- Multi-master mode on the server.
- Configurable behavior for sending exceptions.
- Full control over ‘packetization’ timers.
- A configurable Auxiliary IP port number for applications that do not support port 502.

Section 3.1.5
DNP protocol features

- ‘Packetization’ per protocol specification.
- CRC checking in message headers received from the serial port.
- Local and remote source address learning.

Section 3.1.6
Microlok protocol features

- ‘Packetization’ per protocol specification.

Section 3.1.7
WIN protocol features

- ‘Packetization’ following the protocol requirements.
- CRC checking for messages received from the serial port.

Section 3.1.8
TIN protocol features

- Support for two modes of TIN protocol.
- ‘Packetization’ following the protocol requirements.
- CRC checking for messages received from the serial port.
- Remote source address learning, specific for two different modes.

Section 3.1.9
TelnetComPort protocol features

- RawSocket protocol with additional support for the serial break signal.
- Compliant with RFC2217.

Section 3.2
Serial Protocols Operation

Section 3.2.1
Serial Encapsulation Applications

Section 3.2.1.1
Character Encapsulation (Raw Socket)

Character encapsulation is used any time a stream of characters must be reliably transported across a network.

Character streams can be created by any type of device. The baud rates supported at either server need not be the same. If configured, the server will obey XON/XOFF flow control from the end devices.

Figure 58: Character Encapsulation

Section 3.2.1.2
RTU Polling

The following applies to a variety of RTU protocols, including Modbus ASCII and DNP.

NOTE
If a given device or service employs a serial protocol that is supported by ROS, it is advised to configure ROS to use that particular protocol, rather than another one (e.g. RawSocket) that can be made to be (partly) compatible.

Host equipment may connect directly to a server via a serial port, may use a port redirection package, or may connect natively to the (Ethernet / IP) network.

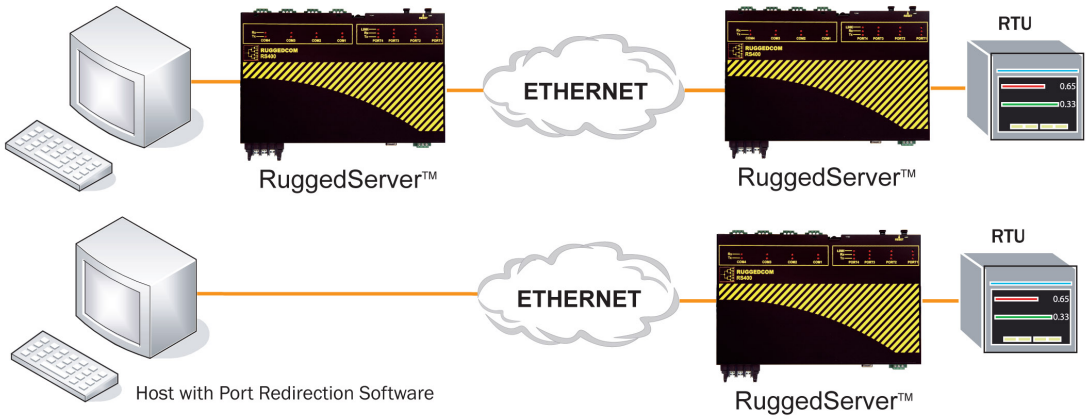


Figure 59: RTU Polling

If a server is used at the host end, it will wait for a request from the host, encapsulate it in an IP Datagram and send it to the remote side. There, the remote server will forward the original request to the RTU. When the RTU replies, the server will forward the encapsulated reply back to the host end.

The server maintains configurable timers to help decide if replies and requests are complete.

The server also handles the process of line-turnaround when used with RS485. It is important to mention that unsolicited messages from RTUs in half-duplex mode cannot be supported reliably. Message processing

time includes sending a message over RS485, a packtimer and a turnaround time. In order to handle half-duplex mode reliably, the turnaround time must be configured long enough to allow an expected response to be received. Any other messages will not be sent to the RS485 line within the processing time. If such a message is received from the network, it will be delayed. It is up to the application to handle polling times on ports properly.

Section 3.2.1.3
Broadcast RTU Polling

Broadcast polling allows a single host-connected server to “fan-out” a polling stream to a number of remote RTUs.

The host equipment connects via a serial port to a server. Up to 64 remote servers may connect to the host server via the network.

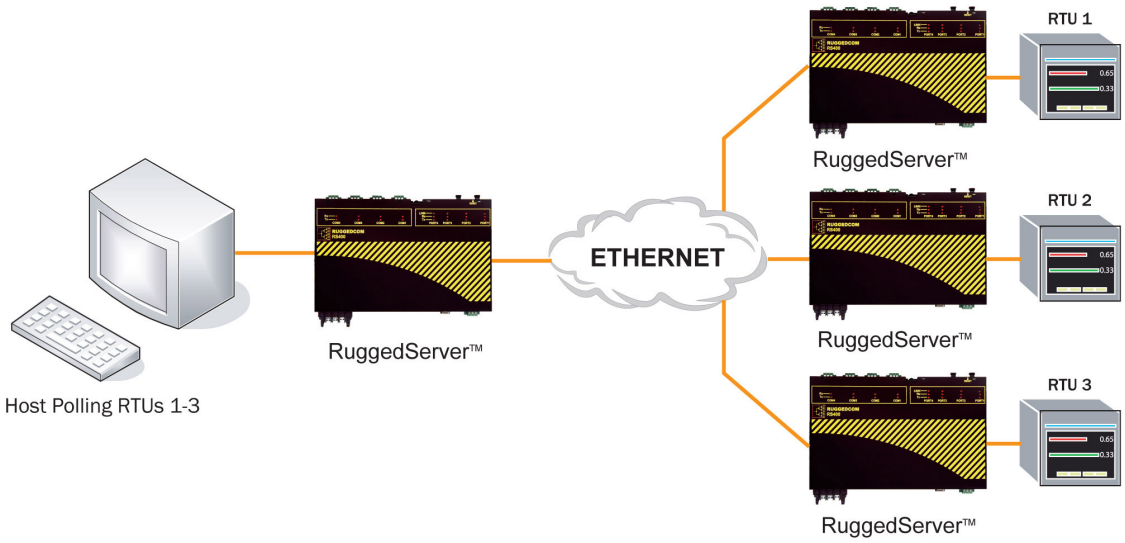


Figure 60: Broadcast RTU Polling

Initially, the remote servers establish connections with the host server. The host server is configured to accept a maximum of three incoming connections.

The host sequentially polls each RTU. Each poll received by the host server is forwarded (i.e. broadcast) to all of the remote servers. All RTUs receive the request and the appropriate RTU issues a reply. The reply is returned to the host server, where it is forwarded to the host.

Section 3.2.1.4
Preemptive Raw Socket

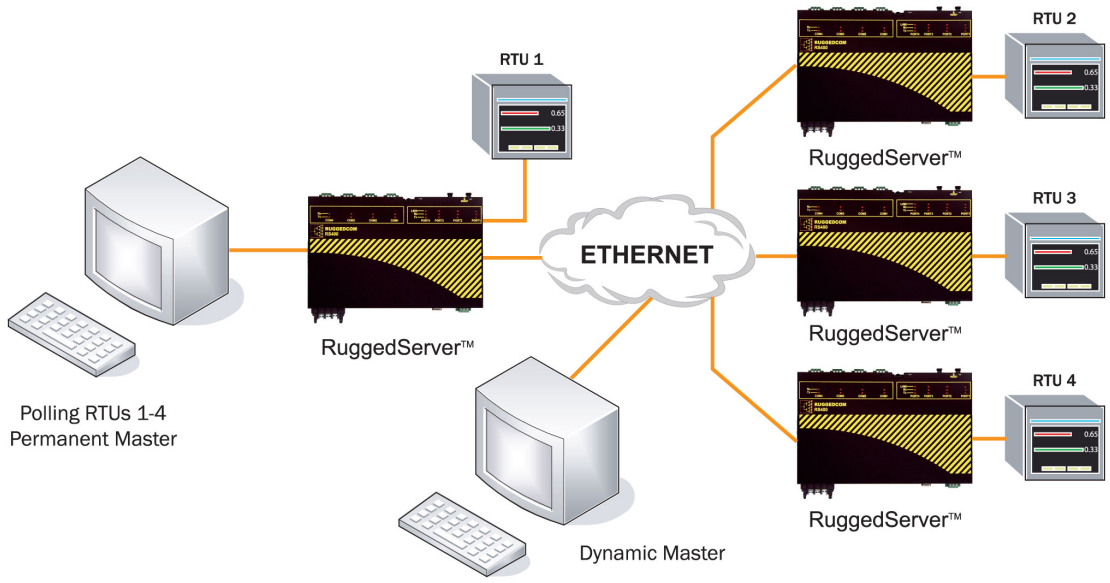


Figure 61: Permanent and Dynamic Master Connection Support

Most SCADA protocols are master/slave and support only a single master device. Preemptive Raw Socket offers the ability to have multiple masters communicate to RTUs/IEDs in a protocol-independent manner. For example, the SCADA master polling device is the normal background process collecting data from the RTUs/IEDs on permanent TCP connection. Occasionally, RTU/IED maintenance configuration or control may be required from a different master (on dynamic TCP connection).

This feature allows a dynamic master to automatically preempt a permanent master. A connection request from the dynamic master would cause the permanent master to be suspended. Either closing the dynamic connection or timing out on data packets causes the permanent master session to be resumed.

The diagram, Figure 61, “Permanent and Dynamic Master Connection Support”, shows the case where all RTUs are connected to Preemptive Raw Socket ports of RS416 devices. The permanent master is connected to the Raw Socket port of the RS416. Raw Socket is configured to be connected to all Preemptive Raw Socket ports where polled RTUs are connected (multiple incoming connection). Preemptive Raw Socket configuration on all ports connected to RTUs will point to that Raw Socket as a permanent master (IP address and Remote IP port).

A dynamic master can establish a connection to any Preemptive Raw Socket port at any time and temporarily suspend the polling process (until the dynamic connection is cleared or times out).

Section 3.2.1.5
Use of Port Redirectors

Port redirectors refer to software packages that emulate the existence of serial communications ports. The redirector software creates and makes these “virtual” serial ports available, providing access to the network via a TCP connection.

When a software package uses one of the virtual serial ports, a TCP connection request is sent to a remote IP address and IP port that have been programmed into the redirector. Some redirectors also offer the ability to accept connection requests.

The RawSocket protocol is the one most frequently used on the RS416 for connection to serial port redirection software. The TelnetComPort protocol may be used in place of RawSocket if the redirection software on the other end of the connection also supports the serial break command, as defined in RFC2217. In TelnetComPort mode, a serial break received from the remote RFC2217-compatible client will be transmitted as a serial break on the configured serial port, and a break signal received on the serial port will be transmitted as an RFC2217-compatible break signal to the remote client. Note that a break signal on a serial port is defined as a condition where the serial data signal is in 'space', or logic zero, state for longer than the time needed to transmit one whole character, including start and stop bits.

Section 3.2.1.6
Message Packetization

The serial server buffers received characters into packets in order to improve network efficiency and demarcate messages.

The server uses three methods to decide when to packetize and forward the buffered characters to the network:

- Packetize on a specific character.
- Packetize on timeout.
- Packetize on a specific packet size.

If configured to packetize on a specific character, the server will examine each received character and will packetize and forward upon receiving the configured character. The character is usually a <CR> or an <LF> character but may be any 8 bit (0 to 255) value.

If configured to packetize on a timeout, the server will wait for a configurable time after receiving a character before packetizing and forwarding. If another character arrives during the waiting interval, the timer is restarted. This method allows characters transmitted as part of an entire message to be forwarded to the network in a single packet, when the timer expires after receiving the very last character of the message.

NOTE
Some polling software packages which perform well under DOS have been known to experience problems when used with Windows-based software or port redirection software. If the OS does not expedite the transmission of characters in a timely fashion, pauses in transmission can be interpreted as the end of a message. Messages can be split into separate TCP packets. A locally attached server or a port redirector could packetize and forward the message incorrectly. Solutions include tuning the OS to prevent the problem or increasing the packetizing timer.

Finally, the server will always packetize and forward on a specific packet size, i.e. when the number of characters received from the serial port reaches a configured value.

Section 3.2.2

Modbus Server and Client Applications

The Modbus Server and Client applications are used to transport Modus requests and responses across IP networks.

The Modbus Client application accepts Modbus polls from a master and determines the IP address of the corresponding RTU. The client then encapsulates the message in TCP respecting TCPModbus protocol, and forwards the frame to a Server Gateway or native TCPModbus RTU. Returning responses are stripped of their TCP headers and issued to the master.

The Modbus Server application accepts TCP encapsulated TCPModbus messages from Client Gateways and native masters. After removing the TCP headers, the messages are issued to the RTU. Responses are TCP encapsulated and returned to the originator.

The following figure presents a complex network of Client Gateways, Server Gateways and native TCPModbus devices.

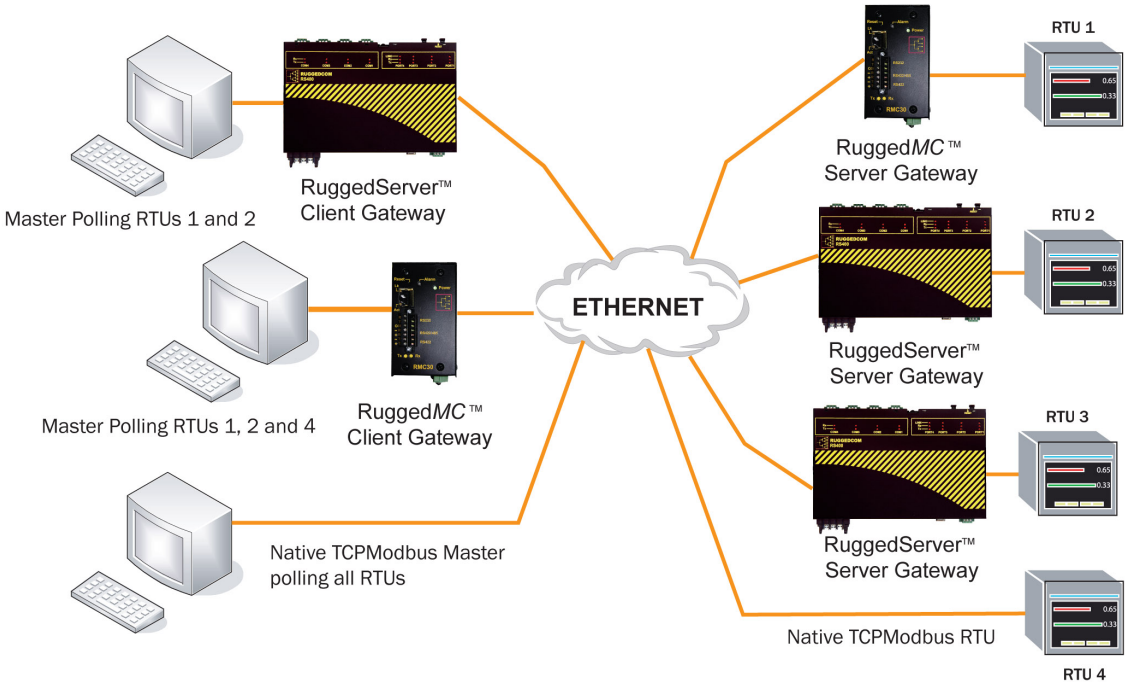


Figure 62: Modbus Client and Server

Section 3.2.2.1

TCPModbus Performance Determinants

The following description provides some insight into the possible sources of delay and error in an end-to-end TCPModbus exchange.

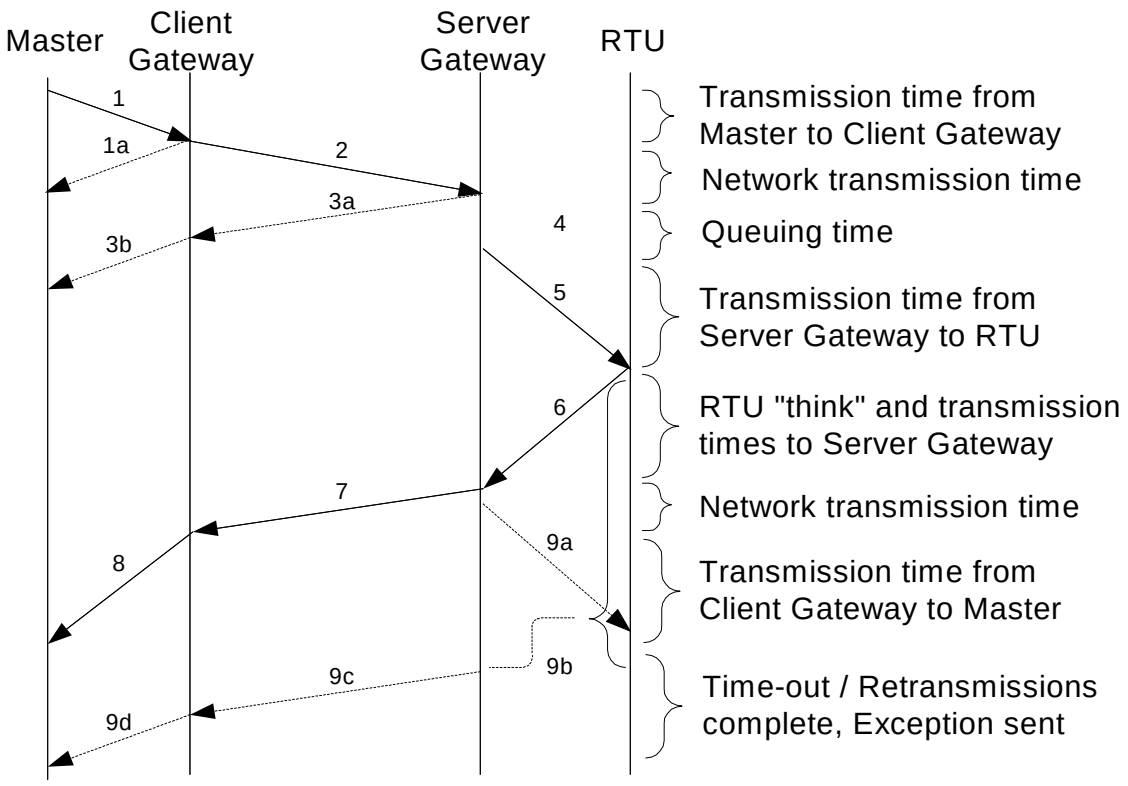


Figure 63: Sources of Delay and Error in an End-to-End Exchange

In step 1, the master issues a request to the Client Gateway. If the Client Gateway validates the message, it will forward it to the network as step 2.

The Client Gateway can respond immediately in certain circumstances, as shown in step 1a. When the Client Gateway does not have a configuration for the specified RTU, it will respond to the master with an exception using TCPModbus exception code 11 (“No Path”). When the Client Gateway has a configured RTU but the connection is not yet active, it will respond to the master with an exception using TCPModbus exception code 10 (“No Response”). If the forwarding of TCPModbus exceptions is disabled, the client will not issue any responses.

Steps 3a and 3b represent the possibility that the Server Gateway does not have a configuration for the specified RTU. The Server Gateway will always respond with a type 10 (“No Path”) in step 3a, which the client will forward in step 3b.

Step 4 represents the possibility of a queuing delay. The Server Gateway may have to queue the request while it awaits the response to a previous request. The worst case occurs when a number of requests are queued for an RTU that has gone off-line, especially when the server is programmed to retry the request upon failure.

Steps 5-8 represent the case where the request is responded to by the RTU and is forwarded successfully to the master. It includes the “think time” for the RTU to process the request and build the response.

Step 9a represents the possibility that the RTU is off-line, the RTU receives the request in error or that the Server Gateway receives the RTU response in error. The Server Gateway will issue an exception to the originator. If sending exceptions has not been enabled, the Server Gateway will not send any response.

Section 3.2.2.2
A Worked Example

A network is constructed with two masters and 48 RTUs on four Server Gateways. Each of the masters is connected to a Client Gateway with a 115.2 Kbps line. The RTUs are restricted to 9600 bps lines. The network is Ethernet-based and introduces an on average 3 ms of latency. Analysis of traces of the remote sites has determined that the min/max RTU think times were found to be 10/100 ms. What time-out should be used by the master?

The maximum length of a Modbus message is 256 bytes. This leads to a transmission time of about 25 ms at the Master and 250 ms at the RTU. Under ideal circumstances, the maximum round trip time is given by: 25 ms (Master->client) + 3 ms (network delay) + 250 ms (server->RTU) + 100 ms (Think time) + 250 ms (RTU->server) + 3 ms (network delay) + 25 ms (client->Master). This delay totals about 650 ms.

Contrast this delay with that of a “quick” operation such as reading a single register. Both request and response are less than 10 bytes in length and complete (for this example) in 1 and 10 ms at the client and server. Assuming the RTU responds quickly, the total latency will approach 35 ms.

The server can already be busy sending a request when the request of our example arrives. Using the figures from the above paragraph, the server being busy would increase the end-to-end delay from 650 to 1250 ms (additional 250 ms (server->RTU) + 100 ms (Think time) + 250 ms (RTU->server)).

The preceding analysis suggests that the Master should time-out at some time after 1250 ms from the start of transmission.

Section 3.2.2.3
Use of Turnaround Delay

Modbus protocol uses the concept of a turnaround delay in conjunction with broadcast messages. When the host sends a broadcast message (that does not invoke an RTU response), it waits for a turnaround delay time. This delay ensures that the RTU has enough time to process the broadcast message before it receives the next poll.

When polling is performed over TCP, network delays may cause the broadcast and next poll to arrive at the remote server at the same time. Configuring a turnaround delay at the server will enforce a minimum separation time between each message transmitted via the serial port.

Note that turnaround delays do not need to be configured at the host computer side and may be disabled there.

Section 3.2.3
DNP 3.0, Microlok, TIN and WIN Applications

RS416 supports a variety of protocols that specify source and destination addresses. A destination address specifies which device should process the data, and the source address specifies which device sent the message. Having both destination and source addresses satisfies at least one requirement for peer-to-peer communication because the receiver knows where to direct responses. Each device supporting one of these protocols must have a unique address within the collection of devices sending and receiving messages to and from each other.

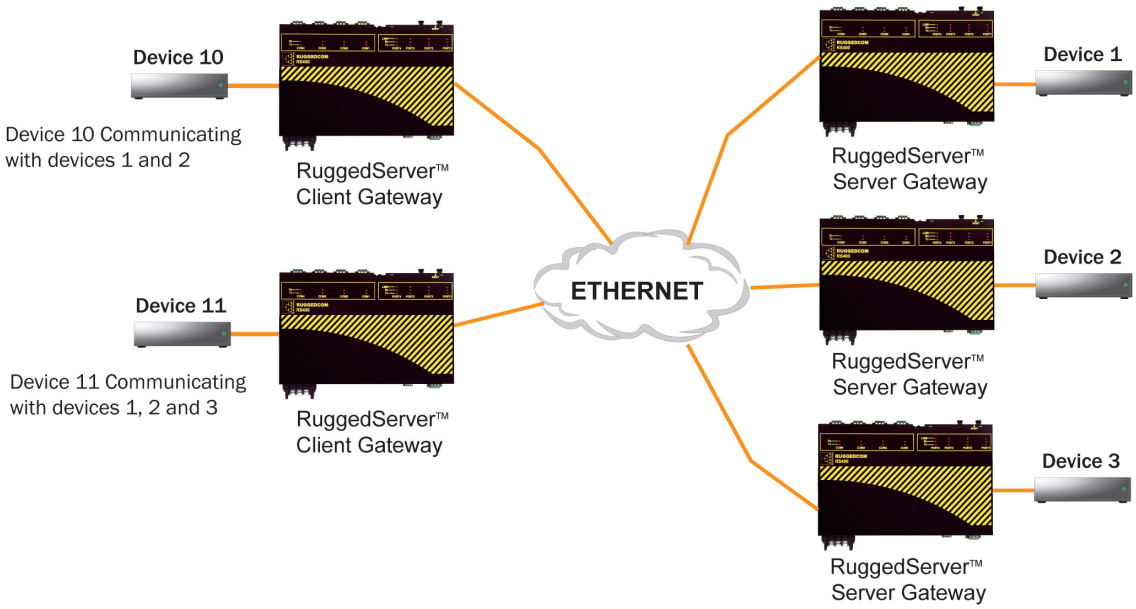


Figure 64: Source/Destination Two-Way Communication

Even if the protocol can distinguish between the server and client sides, RS416 does not do so. Both sides need to know where on the network a given destination device is. If a message is received from the network, the destination address must point to the serial port on the receiving server. If a message is received from the local serial port, the destination address must point to the IP address of the server where the addressed device is connected.

Section 3.2.3.1
The Concept of Links

A communication link is established between two IP addresses. The addressing is described below:

- The *remote address* is the source IP address in a message received over the network, and also the destination address of a message received from a serial port and transmitted on the network.
- The *local address* is the destination IP address in a message received over the network, and also the source address of a message received from a serial port and transmitted on the network.

For each link, a statistical record will be available to the user if link statistics collection is enabled in the protocol configuration.

Section 3.2.3.2
Address Learning for TIN

Address learning is implemented for the TIN protocol and learned entries are viewable in the Figure 89, “Dynamic Device Address Table”.

Address Learning for TIN Mode 1

When a message with an unknown source address is received from the IP network, it is learned on the IP address and IP port. If a message with the same source address is received from another IP address and/or IP port, the address will be relearned.

The aging time will be reset whenever a unicast TIN message is received from a particular source address.

The address will be removed from the table when the aging time expires.

Address Learning for TIN Mode 2

When a message with an unknown source address is received from the IP network, it is learned on the IP address. If a message with the same source address is received from another IP address and/or IP port, it will be learned again, and another entry will be created in the Dynamic Device Address Table (TIN addresses will be duplicated).

Aging time will be reset whenever a unicast TIN message is received from a particular source address.

The address will be removed from the table when the aging time expires.

Section 3.2.3.3

Address Learning for DNP

For the DNP protocol, both the local and remote concepts of address learning are implemented. Source addresses are learned from messages received from the network for specific IP Addresses. Source addresses from messages received from the serial ports are learned for specific local serial ports.

Although the DNP protocol can be configured for TCP or UDP transport, UDP transport is used during the address learning phase as it supports all types of IP addresses: unicast, multicast and broadcast.

When a message with an unknown source address is received from the local serial port, the address is learned on that port and the local IP address.

When a message with an unknown source address is received from the IP network, on IP interface that is configured as learning interface, it is learned on the IP address of the sender and serial port is unknown.

When a message with an unknown destination address is received from a serial port, a UDP broadcast datagram is transmitted on the UDP port configured for the DNP protocol. The IP interface that transmits this broadcast is the one configured as the learning interface.

When a message with an unknown destination address is received from the IP network, it is sent to all DNP serial ports.

All learned addresses will be kept in the Device Address Table until they are active. They will also be saved in non-volatile memory and recovered if the device reboots, so the learning process does not have to be repeated because of, for example, an accidental power interruption.

The aging timer is reset whenever a message is received or sent to the specified address.

This concept makes the DNP protocol configurable with the minimum number of parameters: an IP port, a learning IP interface and an aging timer.

Section 3.2.3.4
Broadcast Messages

DNP Broadcast Messages
Addresses 65521 through 65535 are DNP 3.0 broadcast addresses. RS416 supports broadcasts sending messages with those destination addresses received from serial ports to all IP Addresses found in the Device Address Table (either learned or statically configured). When a DNP broadcast message is received from the IP network, it will be distributed to all ports configured to support the DNP protocol.

TIN Broadcast Messages
TIN broadcast messages can be received only from devices connected to the serial ports.

TIN Mode 1 Broadcast Messages
These messages will be sent to all TIN Address/Ports found in the Dynamic Address Table.

TIN Mode 2 Broadcast Messages
These messages will be sent according to the configuration: to all TIN addresses on every IP address found in the Dynamic Address Table and/or to all Wayside Data Radio IP addresses found in the Static Device Address Table.

Section 3.2.3.5
Transport Protocols

For supported protocols, with exception of Modbus, either UDP datagram or TCP connection packets can be used to transport protocol data over the IP network. The Modbus data can be transported only using TCP connection, following TCPModbus protocol. UDP supports all the addressing modes of IP – unicast, multicast and broadcast. Therefore, if address learning is enabled, UDP broadcasts will be sent across the network.

Transport for Raw Socket
The TCP transport for RawSocket requires configuration of connection request direction, remote IP address, and IP port for listening or requesting outgoing TCP connections. Only one outgoing connection can be requested, but up to 64 connections can be accepted if the port is configured to listen to incoming connection requests. For ports configured to request connections and to listen to incoming connection requests, only one connection can become active.

RS416 will attempt to connect periodically if the first attempt fails and after a connection is broken.

RS416 can be used to connect to any device supporting TCP (e.g. a host computer's TCP stack or a serial application on a host using port redirection software).

If Raw Socket ports are configured to use UDP for transport, up to 64 remote hosts can communicate with devices connected to local serial ports. Data in UDP packets from remote hosts configured to communicate with a particular serial port will be forwarded to that port, as long as the serial port is configured to listen on the UDP port to which the remote hosts are transmitting. Data received from the serial port will be forwarded to all remote hosts configured to communicate with that serial port.

The Raw Socket mechanism transparently passes data. It does not attempt to determine where to demarcate packets in the data received from connected devices. Given this transparency, any protocol can be encapsulated within Raw Socket.

Transport for Protocols with Defined Links
All protocols with defined links (source and destination addresses are part of protocol) can use either TCP or UDP to transport data.

The Device Address Table contains addresses and locations of devices configured (or learned) for specific protocols.

If a protocol is configured to use TCP to transport data, the server will start listening to the IP Port configured for the protocol. At the same time, TCP connections will be placed to all IP addresses where devices for that protocol are attached. RS416 will keep only one connection open to one IP Address on one IP Port.

Use of Differentiated Services Code Point (DSCP)

RS416 has the ability to set the DS byte in the IP header of outbound IP packets. The value can be configured on an ingress serial port, and/or for a protocol. Which value will be used depends on the protocol configured on a port and the transport configured for the particular protocol.

UDP/IP transport supports a DSCP setting per serial port or per protocol. If a configuration contains a DSCP setting per serial port as well as per protocol then the system will use whichever setting has a higher DSCP value.

TCP/IP transport supports per protocol DSCP setting. RawSocket and Modbus Server protocol properties are configured per port as well, so they always support DSCP setting per serial port.

Section 3.2.4

Force Half-Duplex Mode of Operation

A "force half-duplex" mode of operation allows use of extensions that create echo loops (as optical loop topology that utilizes the RMC20 repeat mode function).

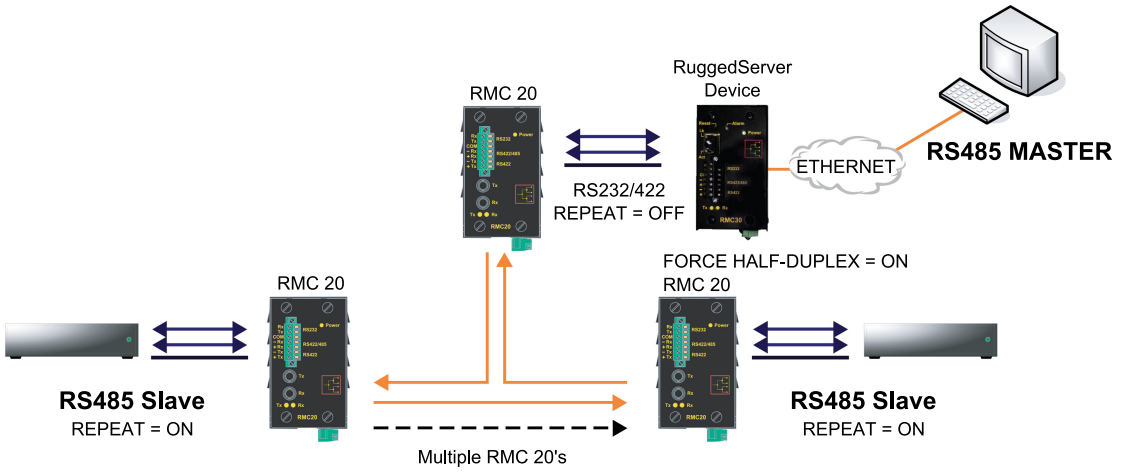


Figure 65: Optical Loop Topology

The diagram: Figure 65, “Optical Loop Topology” illustrates a topology that utilizes the RMC20 repeat mode function. The repeat function will optically retransmit any data received on the optical receiver, in addition to any connected serial devices. As a result, any data transmitted from the master will be retransmitted optically to all the slaves.

This topology can be used for RS232, RS485, or RS422 multi-drop networks. In all cases, all slaves have the repeat function (DIP position 4) ON, while the one connected to the RMC30 is configured with the repeat

function OFF. The port used on the RMC30 must be in full-duplex mode, while the ForceHD (Force Half-Duplex) parameter must be turned ON.

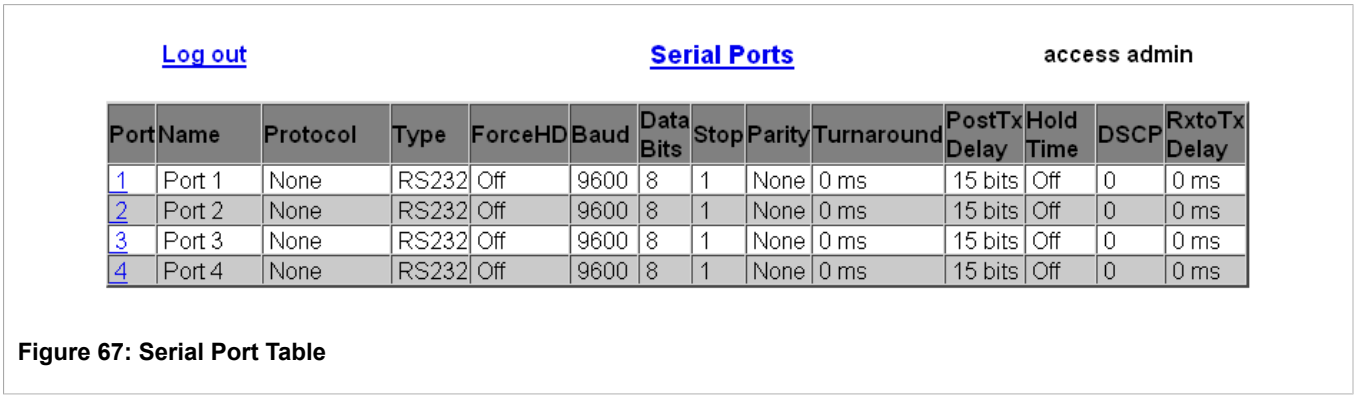
Section 3.3

Serial Protocol Configuration

The Serial Protocols menu is accessible from the main menu:

Figure 66: Serial Protocols Menu

Section 3.3.1
Serial Ports



Port	Name	Protocol	Type	ForceHD	Baud	Data Bits	Stop	Parity	Turnaround	PostTx Delay	Hold Time	DSCP	RxtoTx Delay
1	Port 1	None	RS232	Off	9600	8	1	None	0 ms	15 bits	Off	0	0 ms
2	Port 2	None	RS232	Off	9600	8	1	None	0 ms	15 bits	Off	0	0 ms
3	Port 3	None	RS232	Off	9600	8	1	None	0 ms	15 bits	Off	0	0 ms
4	Port 4	None	RS232	Off	9600	8	1	None	0 ms	15 bits	Off	0	0 ms

Figure 67: Serial Port Table

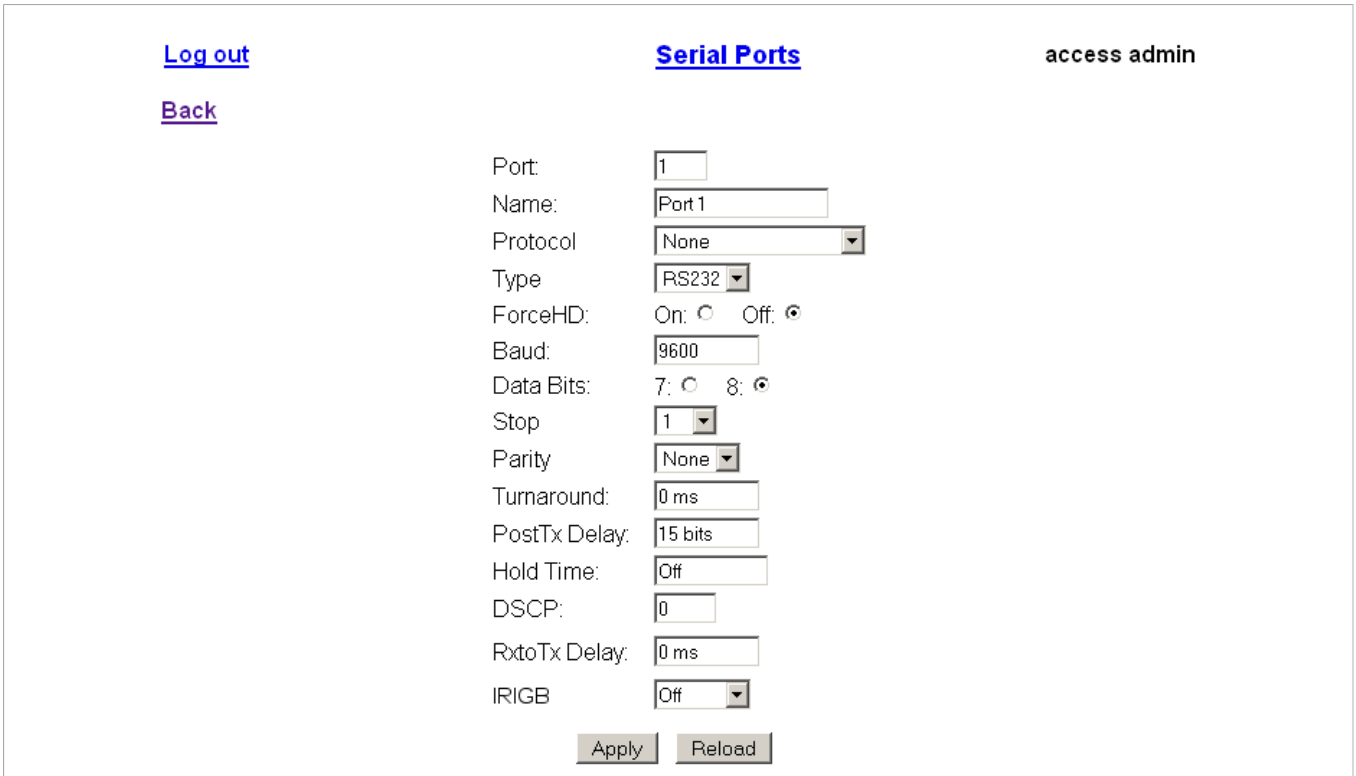


Figure 68: Serial Port Configuration Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
Name	**Synopsis:** Any 15 characters **Default:** Port 1 A descriptive name that may be used to identify the device connected on that port.

Parameter	Description
Protocol	**Synopsis:** { None, RawSocket, ModbusServer, ModbusClient, DNP, DNPRS, WIN, TIN, MicroLok, MirroredBits, PreemptRawSocket, TelnetComPort } **Default:** None The serial protocol supported on this serial port.
Type	**Synopsis:** { RS232, RS485, RS422 } **Default:** RS232 The serial port interface type.
ForceHD	**Synopsis:** { On, Off } **Default:** Off Enables forcing half-duplex mode of operation. While sending data out of the serial port, all received data are ignored. This mode of operation is available only on ports that operate in full-duplex mode.
Baud	**Synopsis:** 100 to 230400 **Default:** 9600 The baud rate at which to operate the port.
Data Bits	**Synopsis:** { 7, 8 } **Default:** 8 The number of data bits to operate the port with.
Stop	**Synopsis:** { 1, 1.5, 2 } **Default:** 1 The number of stop bits to operate the port with.
Parity	**Synopsis:** { None, Even, Odd } **Default:** None The parity to operate the port with.
Turnaround	**Synopsis:** 0 to 1000 **Default:** 0 ms The amount of delay (if any) to insert between the transmissions of individual messages via the serial port. For Modbus protocol this value must be non-zero. It represents the delay between sending a brodcast message and the next poll out of the serial port. Because RTUs do not reply to a broadcast, enough time must be ensured to process it.
PostTX Delay	**Synopsis:** 0 to 15 **Default:** 15 bits The number of data bits needed to generate required delay with configured baudrate after the last bit of the packet was sent out before serial UART starts listening to the RX line. This value is relevant for RS485 interfaces only.
Hold Time	**Synopsis:** 1 to 15000 ms or { off } **Default:** off The maximum amount of time, in milliseconds, that the serial packet can be held in the queue before being sent to the serial line. Time is measured from the moment the packet is received from the IP layer.
DSCP	**Synopsis:** 0 to 63 **Default:** 0 Sets the DS byte in the IP header. DS byte setting is supported in the egress direction only.
RXtoTX Delay	**Synopsis:** 0 ms to 1000 ms **Default:** 0 ms The minimum amount of time, in milliseconds, that the transmission of a new message delays after the last message is received through the serial port. This parameter is especially useful for half duplex transmission modes, such as the two-wire RS485 serial

Parameter	Description
	protocol. It provides the connected device with time to turn off its transmitter and to turn on its receiver, helping to ensure that the device receives the next message without data loss.
IRIGB	**Synopsis:** { PWM, PPS, Off } **Default:** Off The operational mode of the IRIGB port. Possible options are PWM and PPS. PWM (Pulse Width Modulation) mode complies with IRIG Standard 200-04, generating formats IRIGB002 and IRIGB003. PPS (Pulse per Second) provides a generic PPS interface to synchronize external devices. For more information on IRIG-B, see Section 2.11.5, “Configuring IRIG-B”.

Section 3.3.2
Raw Socket

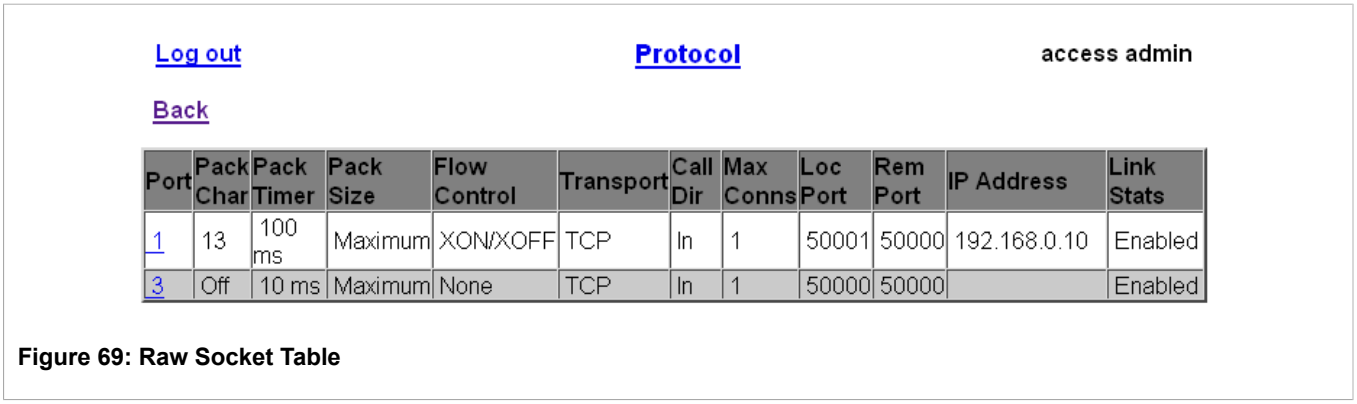


Figure 69: Raw Socket Table

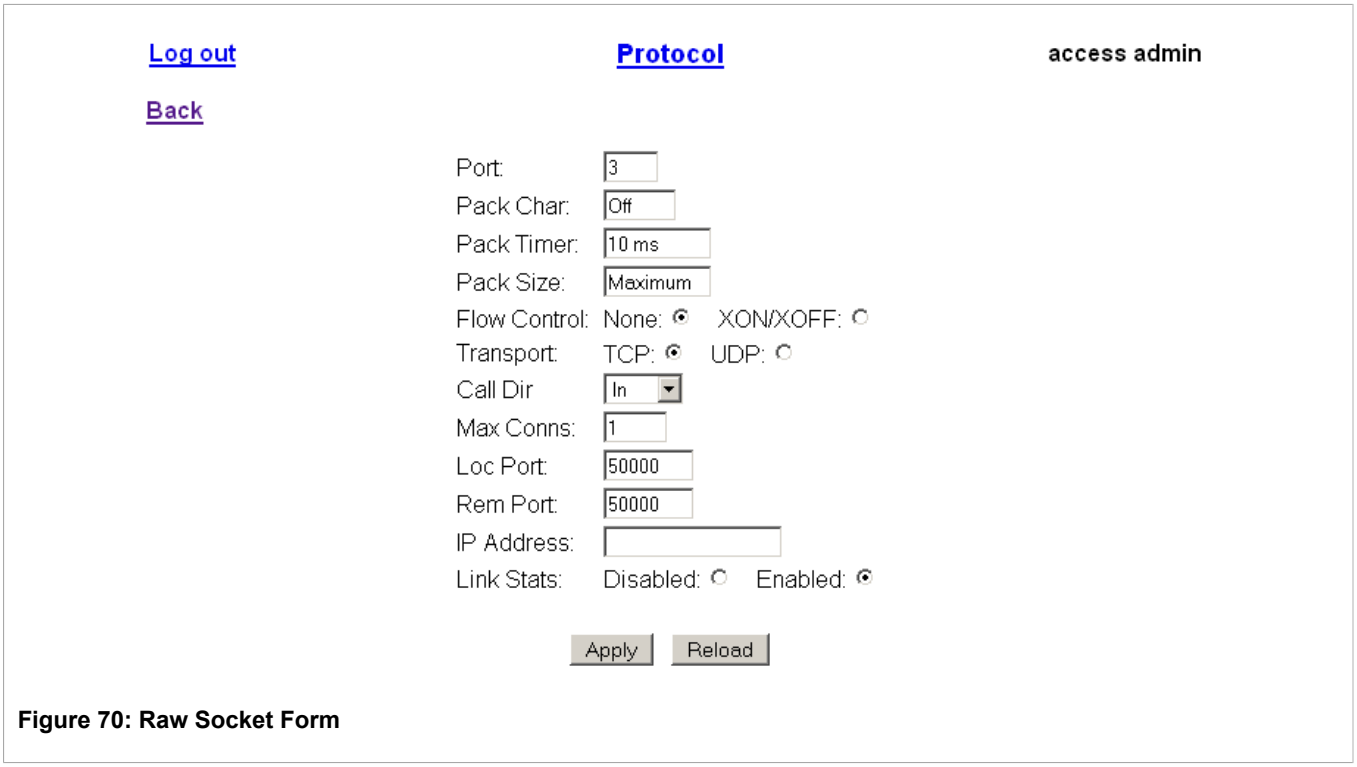


Figure 70: Raw Socket Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
Pack Char	**Synopsis:** 0 to 255 or { Off } **Default:** Off The character that can be used to force forwarding of accumulated data to the network. If a packetization character is not configured, accumulated data will be forwarded based upon the packetization timeout (Pack Timer) parameter.
Pack Timer	**Synopsis:** 1 to 1000 **Default:** 10 ms The delay from the last received character until when data is forwarded. If parameter value is set to be less than 3 ms, there is not guaranty that it will be obeyed. It will be a minimum possible time in which device can react under certain data load.
Pack Size	**Synopsis:** 16 to 1400 or { Maximum } **Default:** Maximum The maximum number of bytes received from serial port to be forwarded.
Pack Size	**Synopsis:** 16 to 1400 or { Maximum } **Default:** Maximum The maximum number of bytes received from the serial port to be forwarded.
Flow Control	**Synopsis:** { None, XON/XOFF } **Default:** None The Flowcontrol setting for serial port.
Transport	**Synopsis:** { TCP, UDP } **Default:** TCP The network transport used to transport protocol data over IP network.
Call Dir	**Synopsis:** { In, Out, Both } **Default:** In The Call direction for TCP Tranport. • Whether to accept an incoming connection or • to place an outgoing connection or • to place outgoing connection and wait for incomming (both directions).
Max Conns	**Synopsis:** 1 to 64 **Default:** 1 The maximum number of allowed incoming TCP connections (for configurations using TCP).
Loc Port	**Synopsis:** 1024 to 65535 **Default:** 50000 The local IP port to use when listening for an incoming connection or UDP data.
Rem Port	**Synopsis:** 1 to 65535 **Default:** 50000 The remote TCP port to use when placing an outgoing connection. Note that this parameter is applicable only to TCP connections. If the transport protocol is set to UDP, the remote port is configured using the "Remote Hosts" table. For more information, see the Section 3.3.3, “Remote Hosts” section.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 or { } Default: For direction: 'Out' (client), the remote IP address to use when placing an outgoing TCP connection request. For direction: 'In' (server), the local interface IP address on which to listen for connection requests. An empty string implies the default: the IP address of the management interface.

Parameter	Description
	For direction: 'Both' (client or server), the remote IP address to use when placing an outgoing TCP connection request. The listening interface will be chosen by matching mask. Note that this parameter is applicable only to TCP connections. If the transport protocol is set to UDP, the remote port is configured using the "Remote Hosts" table. For more information, see the Section 3.3.3, “Remote Hosts” section.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables link statistics collection for the protocol.

Section 3.3.3
Remote Hosts

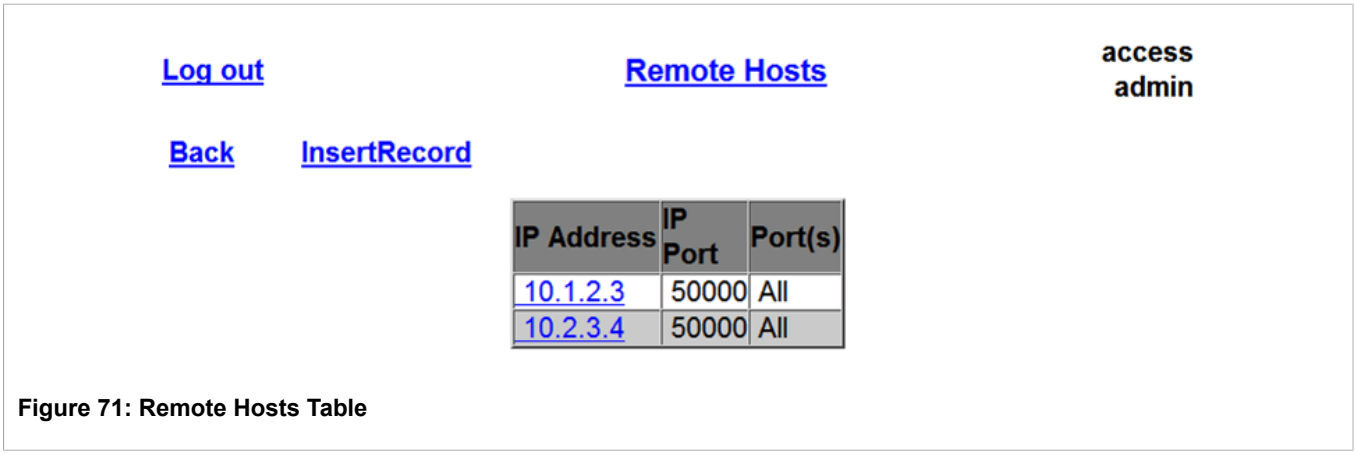


Figure 71: Remote Hosts Table

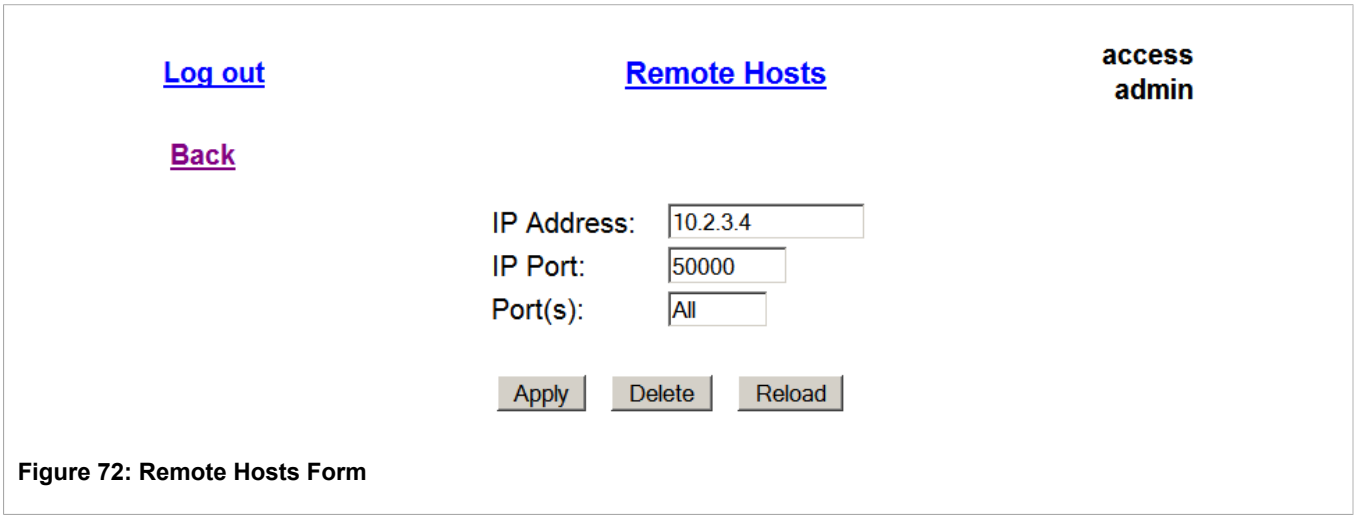


Figure 72: Remote Hosts Form

Parameter	Description
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 **Default:** The IP address of the remote host.
IP Port	**Synopsis:** 1 to 65535 or { Unknown } **Default:** 50000

Parameter	Description
	The IP port that remote host listens to. If this is zero (Unknown), the unit only receives from the remote host but does not transmit to it.
Port(s)	**Synopsis:** Any combination of numbers valid for this parameter **Default:** All The local serial ports that the remote host is allowed to communicate with.

Section 3.3.4

Preemptive Raw Socket

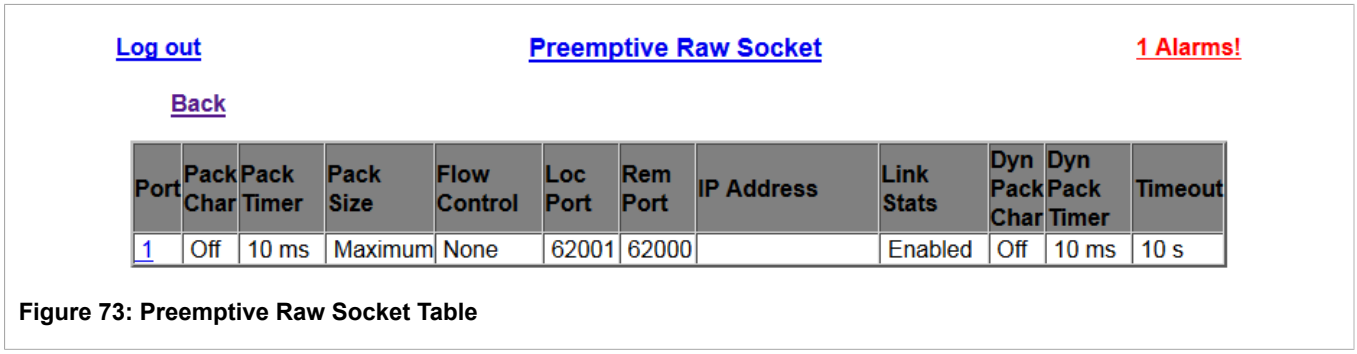


Figure 73: Preemptive Raw Socket Table

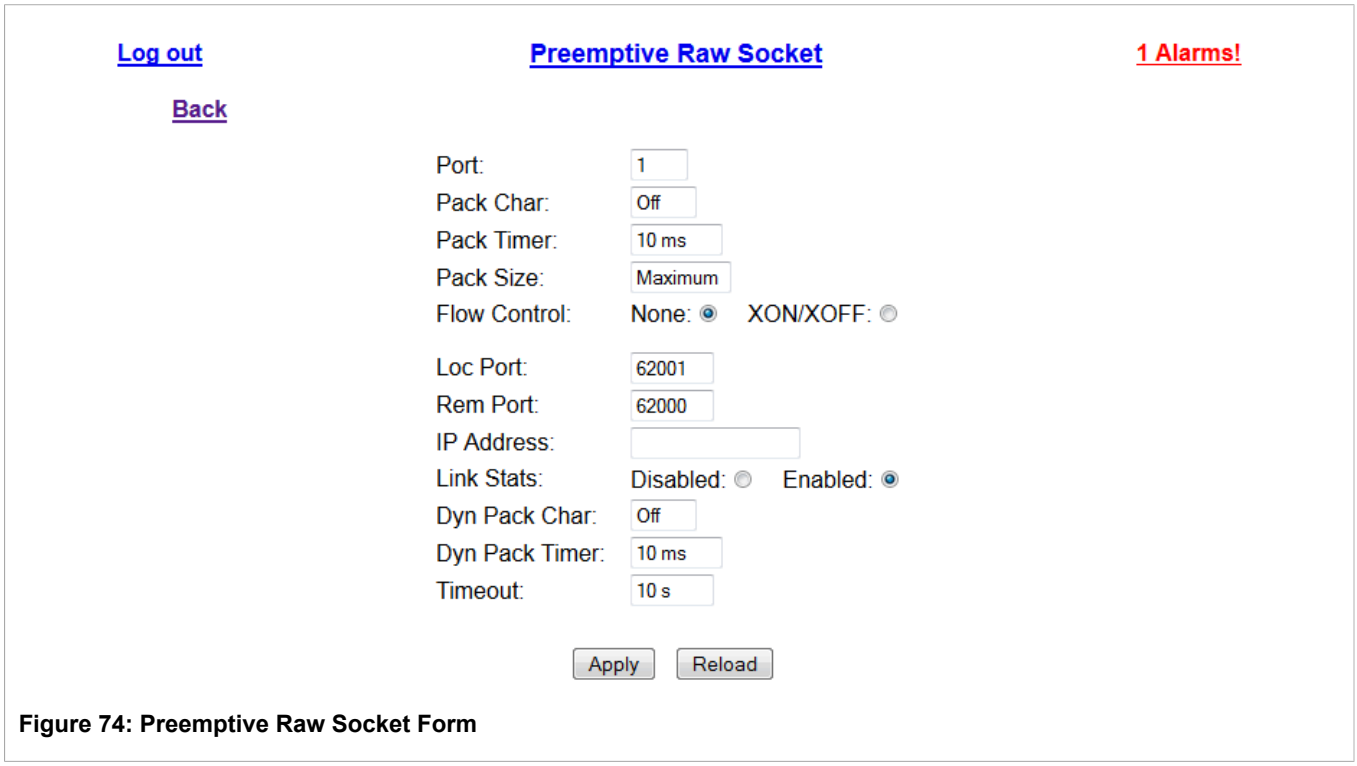


Figure 74: Preemptive Raw Socket Form

Parameter	Description
Port	**Synopsis:** 1 to 4 **Default:** 1 The port number as seen on the front plate silkscreen of the switch.

Parameter	Description
Pack Char	**Synopsis:** 0 to 255 or { Off } **Default:** Off The character that can be used to force forwarding of accumulated data to the network. If a packetization character is not configured, accumulated data will be forwarded based upon the packetization timeout parameter.
Pack Timer	**Synopsis:** 1 to 1000 **Default:** 10 ms The delay from the last received character until when data is forwarded. If parameter value is set to be less than 3 ms, there is not guaranty that it will be obeyed. It will be a minimum possible time in which device can react under certain data load.
Pack Size	**Synopsis:** 16 to 1400 or { Maximum } **Default:** Maximum The maximum number of bytes received from serial port to be forwarded.
Flow Control	**Synopsis:** { None, XON/XOFF } **Default:** None The Flowcontrol setting for serial port.
Loc Port	**Synopsis:** 1024 to 65535 **Default:** 62001 The local IP port to use when listening for an incoming connection or UDP data.
Rem Port	**Synopsis:** 1 to 65535 **Default:** 62000 The remote TCP port to use when placing an outgoing connection.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 or { <EMTY STRING> } Default: The permanent master's IP address. Empty string represents management IP address of this device.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables link statistics collection for this protocol.
Dyn Pack Char	**Synopsis:** 0 to 255 or { Off } **Default:** Off The character that can be used to force the forwarding of accumulated data to the network for connection to a dynamic master. If a packetization character is not configured, accumulated data will be forwarded based upon the packetization timeout parameter.
Dyn Pack Timer	**Synopsis:** 1 to 1000 **Default:** 10 ms The delay from the last received character until when data is forwarded to the dynamic master.
Timeout	**Synopsis:** 10 to 3600 **Default:** 10 s The time in seconds that is allowed for a dynamic master to be idle before its connection is closed. The protocol listens to the socket open to the dynamic master, and if no data are received within this time, the connection will be closed.

Section 3.3.5

Modbus Server

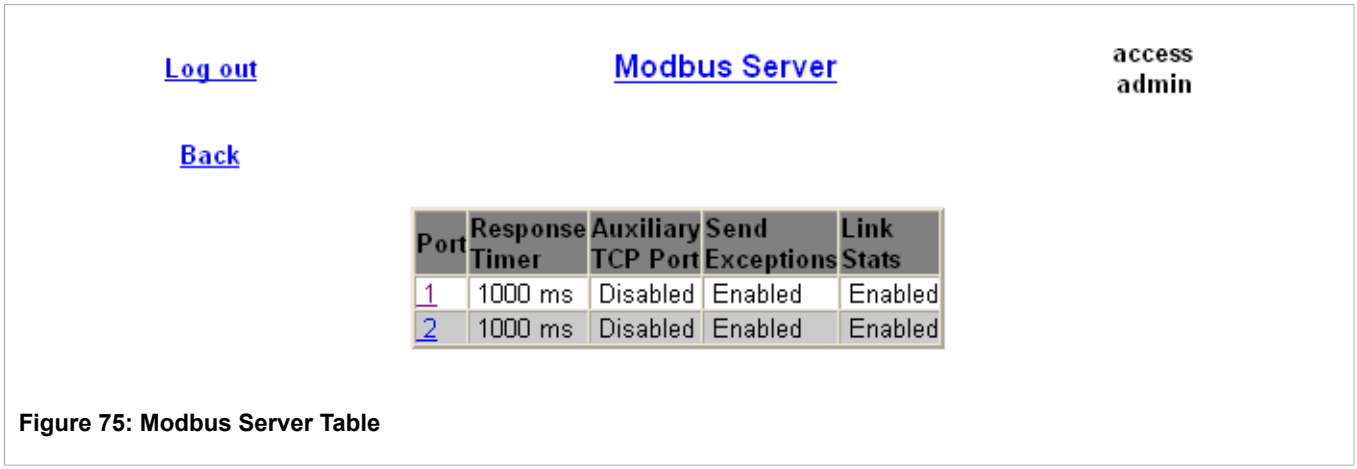


Figure 75: Modbus Server Table

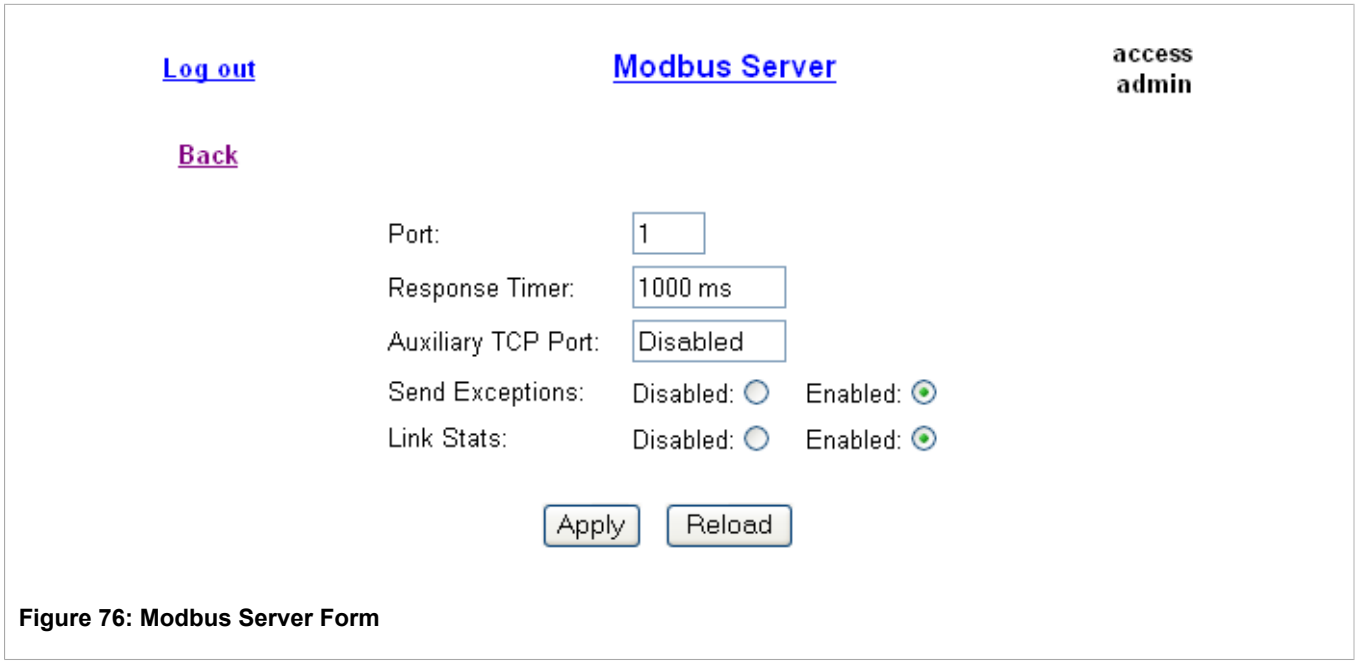


Figure 76: Modbus Server Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
Response Timer	**Synopsis:** 50 to 10000 **Default:** 1000 ms The maximum allowable time to wait for the RTU to start to respond.
Auxiliary TCP Port	**Synopsis:** 1024 to 65535 or { Disabled } **Default:** Disabled The TCP Modbus Server always listens on TCP port 502. It may be additionally configured to listen on this auxiliary port number, accepting calls on both.
Send Exceptions	**Synopsis:** { Disabled, Enabled }

Parameter	Description
	Default: Enabled This parameter enables/disables sending a TCP Modbus exception back to the master if a response has not been received from the RTU within expected time.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables link statistics collection for this protocol.

Section 3.3.6
Modbus Client

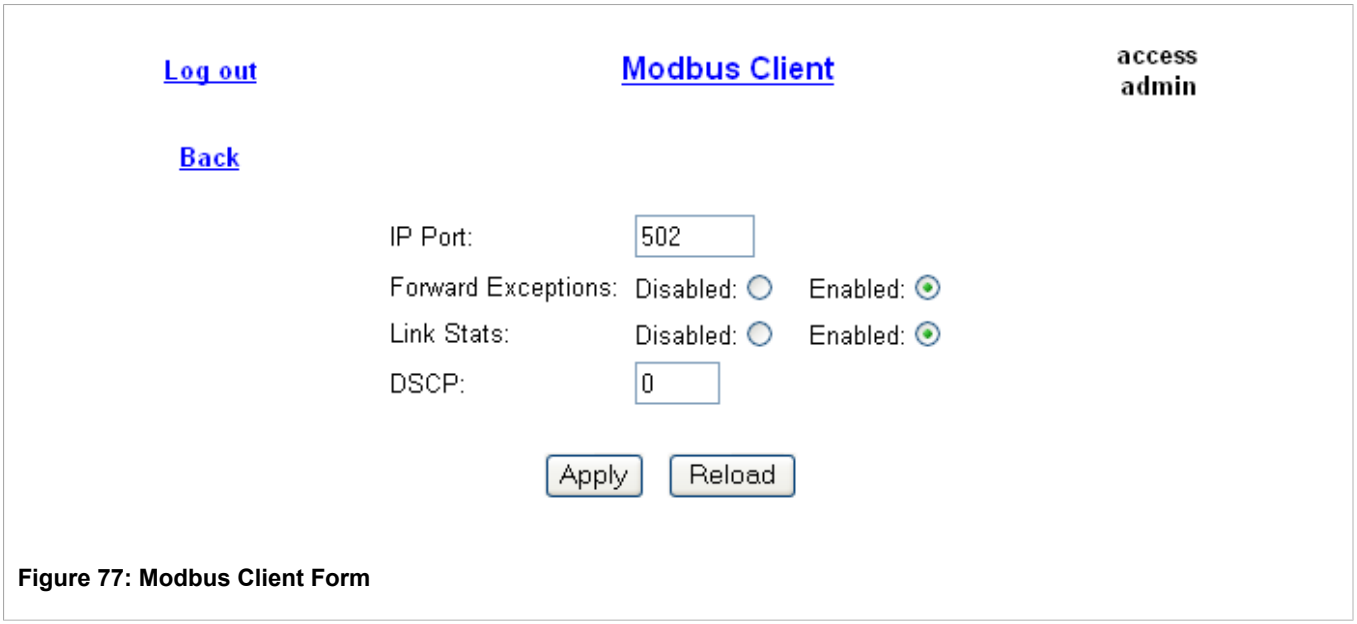


Figure 77: Modbus Client Form

Parameter	Description
IP Port	**Synopsis:** 1 to 65535 **Default:** 502 The remote port number at which the Modbus protocol makes TCP connection requests.
Forward Exceptions	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables forwarding exception messages to the Master as exception codes 10 (no path) or 11 (no response) When the Master polls for an unconfigured RTU or the remote Modbus Server receives a poll for an RTU which is not configured or is timing out, it returns an exception message. Disable this feature if your Master does not support exceptions but recognizes failure by time-out when waiting for response.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables link statistics collection for this protocol.
DSCP	**Synopsis:** 0 to 63 **Default:** 0 To set the DS byte in the IP header. DS byte setting is supported in the egress direction only.

Section 3.3.7

WIN and TIN

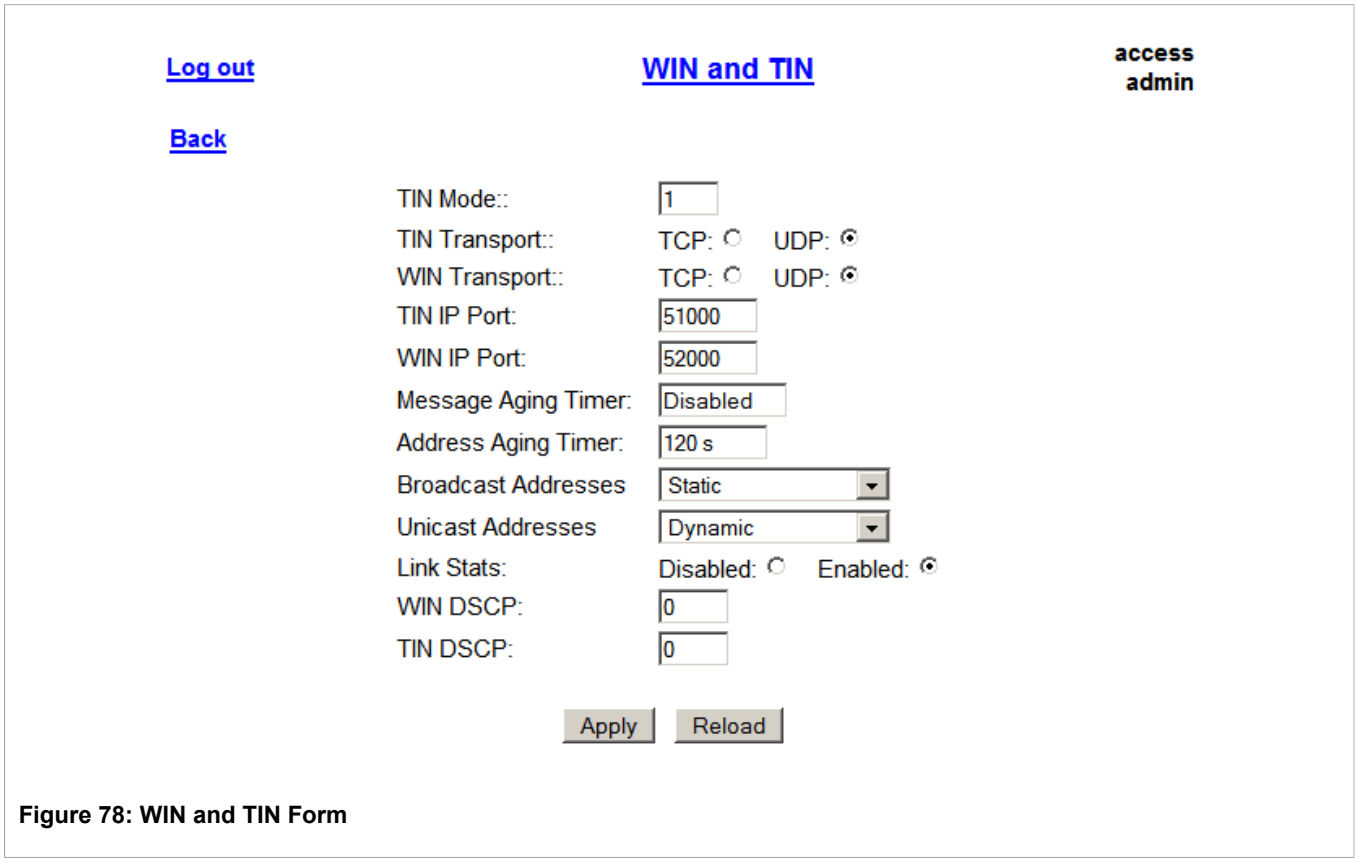


Figure 78: WIN and TIN Form

Parameter	Description
TIN Mode:	**Synopsis:** 1 to 2 **Default:** 1 The TIN Protocol running mode.
TIN Transport:	**Synopsis:** { TCP, UDP } **Default:** UDP The network transport used to transport protocol data over an IP network.
WIN Transport:	**Synopsis:** { TCP, UDP } **Default:** UDP The network transport used to transport protocol data over an IP network.
TIN IP Port	**Synopsis:** 1024 to 65535 **Default:** 51000 The local port number on which the TIN protocol listens for connections or UDP datagrams.
WIN IP Port	**Synopsis:** 1024 to 65535 **Default:** 52000 The local port number on which the WIN protocol listens for connections or UDP datagrams.
Message Aging Timer	**Synopsis:** 1 to 3600 or { Disabled } **Default:** Disabled The Aging Time for TIN mode2 messages. It specifies how long a message should be stored in the internal table. When the feature is enabled, any TIN mode2 message received

Parameter	Description
	will be stored in an internal table which can be examined by using command 'SQL SELECT FROM ItcsTin2Dup'. If the same message is received within the time window specified by this parameter, the new message is considered duplicate, and thus discarded.
Address Aging Timer	**Synopsis:** 60 to 1000 **Default:** 300 s The time of communication inactivity after which a learned TIN address is removed from the device address table. Entries in the Link Statistics Table with the aged address will be kept until statistics are cleared.
Broadcast Addresses	**Synopsis:** { Static, Dynamic, StaticAndDynamic } **Default:** Static The device address table in which addresses will be found for broadcast messages.
Unicast Addresses	**Synopsis:** { Static, Dynamic, StaticAndDynamic } **Default:** Dynamic The device address table in which addresses will be found for unicast messages.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables link statistics collection for this protocol.
WIN DSCP	**Synopsis:** 0 to 63 **Default:** 0 To set the DS byte in the IP header. DS byte setting is supported in the egress direction only.
TIN DSCP	**Synopsis:** 0 to 63 **Default:** 0 To set the DS byte in the IP header. DS byte setting is supported in the egress direction only.

Section 3.3.8

MicroLok

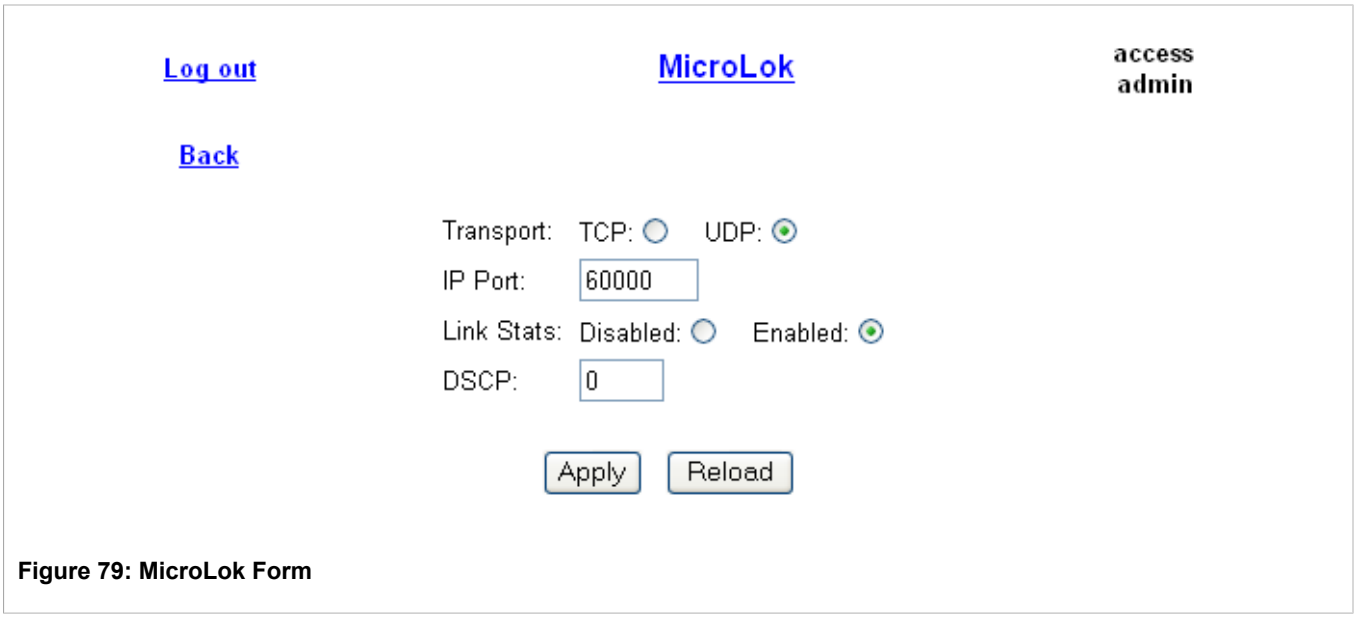


Figure 79: MicroLok Form

Parameter	Description
Transport	**Synopsis:** { TCP, UDP } **Default:** UDP The network transport used to transport protocol data over an IP network.
IP Port	**Synopsis:** 1024 to 65535 **Default:** 60000 A local port number on which the MicroLok protocol listens for UDP datagrams or TCP connections.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables link statistics collection for this protocol.
DSCP	**Synopsis:** 0 to 63 **Default:** 0 To set the DS byte in the IP header. DS byte setting is supported in the egress direction only.

Section 3.3.9
DNP

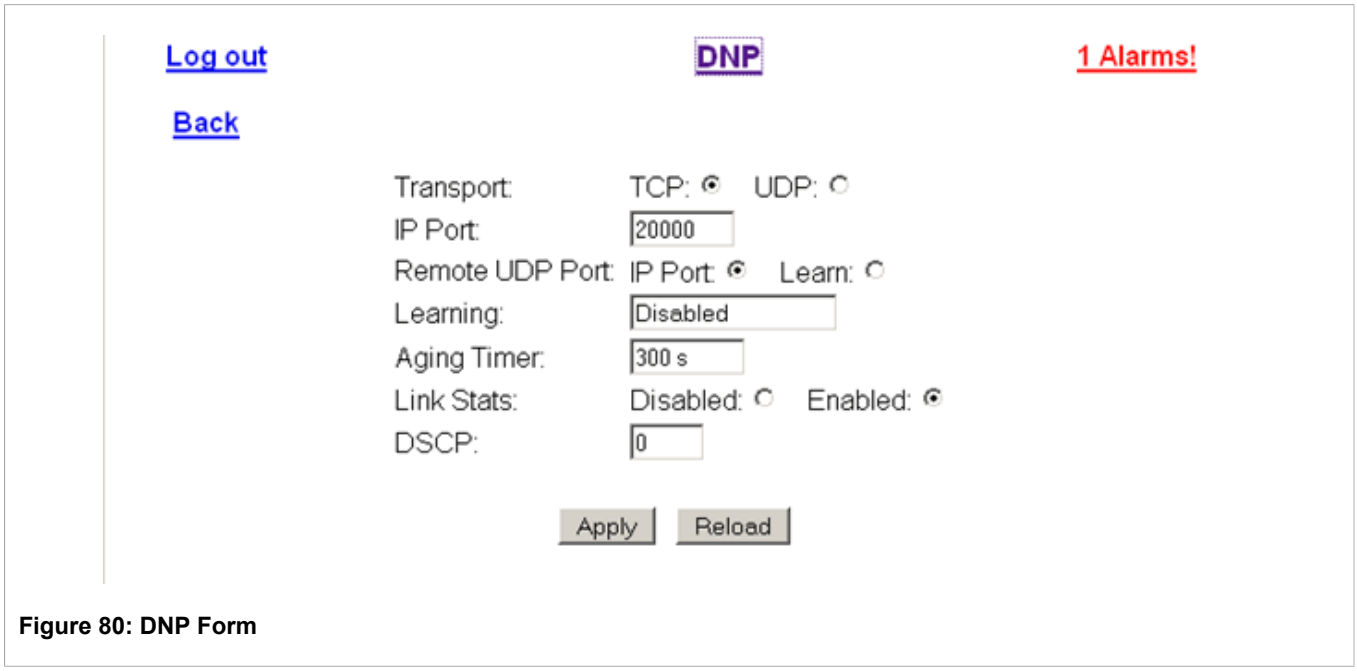


Figure 80: DNP Form

Parameter	Description
Transport	**Synopsis:** { TCP, UDP } **Default:** TCP The network transport used to transport protocol data over an IP network.
IP Port	**Synopsis:** 1024 to 65535 **Default:** 20000 A local port number on which the DNP protocol listens for UDP datagrams.
Remote UDP Port	**Synopsis:** { IP Port, Learn }

Parameter	Description
	Default: IP Port The IP port on which remote device listens to UDP datagrams. This port is either the same IP port that devices in all networks listen to, or can be learned from the UDP datagram.
Learning	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 or { Disabled } **Default:** Disabled Enable or disable address learning. Learning can be disabled or enabled on a management IP interface (empty string), or enabled on the interface with a specific IP address. If learning is enabled and the remote address is not known, a UDP broadcast message will be sent and source addresses will be learned on devices that run the DNP protocol. If the local address is not known, a message will be sent to all serial ports running the DNP protocol. Local addresses will be learned from local responses. If the TCP transport is configured, a connection will be established to the devices with the corresponding IP address.
Aging Timer	**Synopsis:** 60 to 1000 **Default:** 300 s The time of communication inactivity after which a learned DNP address is removed from the device address table. Entries in the Link Statistics Table with the aged address will be kept until the statistics are cleared.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables link statistics collection for this protocol.
DSCP	**Synopsis:** 0 to 63 **Default:** 0 To set the DS byte in the IP header. DS byte setting is supported in the egress direction only.

Section 3.3.10

DNP over Raw Socket

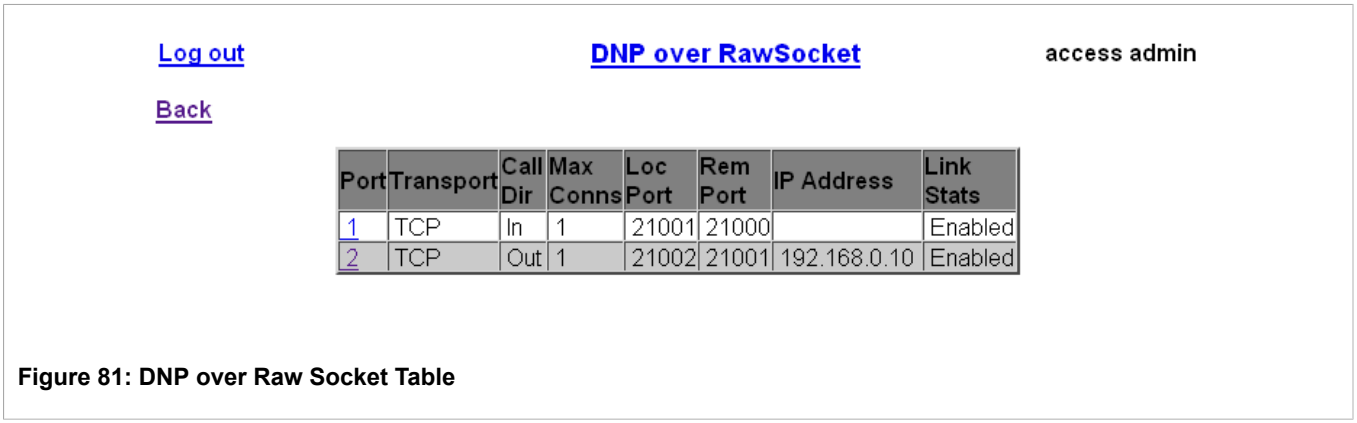


Figure 81: DNP over Raw Socket Table

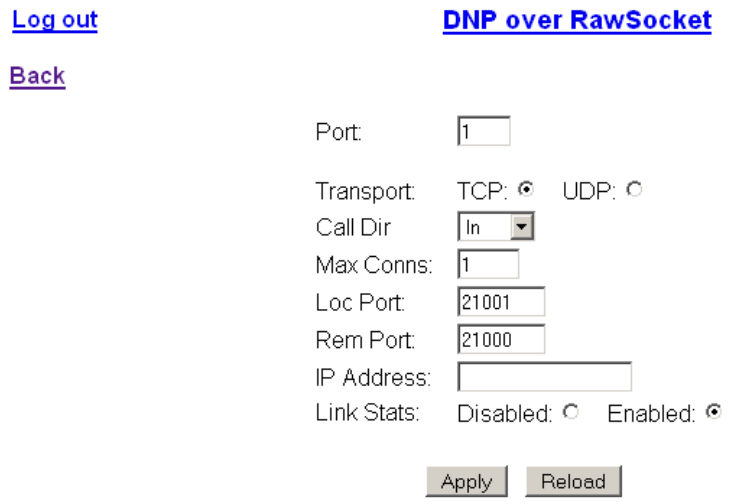


Figure 82: DNP over Raw Socket Form

Parameter	Description
Port	**Synopsis:** 1 to 4 **Default:** 1 The port number as seen on the front plate silkscreen on the switch.
Transport	**Synopsis:** { TCP, UDP } **Default:** TCP The network transport used to transport protocol data over the IP network.
Call Dir	**Synopsis:** { In, Out, Both } **Default:** In The Call direction for TCP Tranport. • In: accepts an incoming connection. • Out: places an outgoing connection. • Both: places an outgoing connection and waits for as incomming connection (both directions).
Max Conns	**Synopsis:** 1 to 64 **Default:** 1 The maximum number of allowed incoming TCP connections.
Loc Port	**Synopsis:** 1 to 65535 **Default:** 21001 The local IP port to use when listening for an incoming connection or UDP data.
Rem Port	**Synopsis:** 1 to 65535 **Default:** 21000 The remote TCP port to use when placing an outgoing connection.
IP Address	**Synopsis:** ###.###.###.### (where ### ranges from 0 to 255) | { <empty string> } **Default:** <empty string> Defines the IP address based on the following: • For outgoing TCP connection (client), this is the remote IP address to communicate with.

Parameter	Description
	• For incoming TCP connection (server), this is the local interface IP address to listen to for the local port for connection request. If an empty string is configured, the IP address of the management interface is used. • When both outgoing and incoming connections are enabled (client or server), this is remote IP address to use to place an outgoing TCP connection request or from which to accept calls. • For UDP transport, this is the IP address of the interface to listen to for UDP datagrams.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables links statistics collection for the protocol.

Section 3.3.11
Mirrored Bits

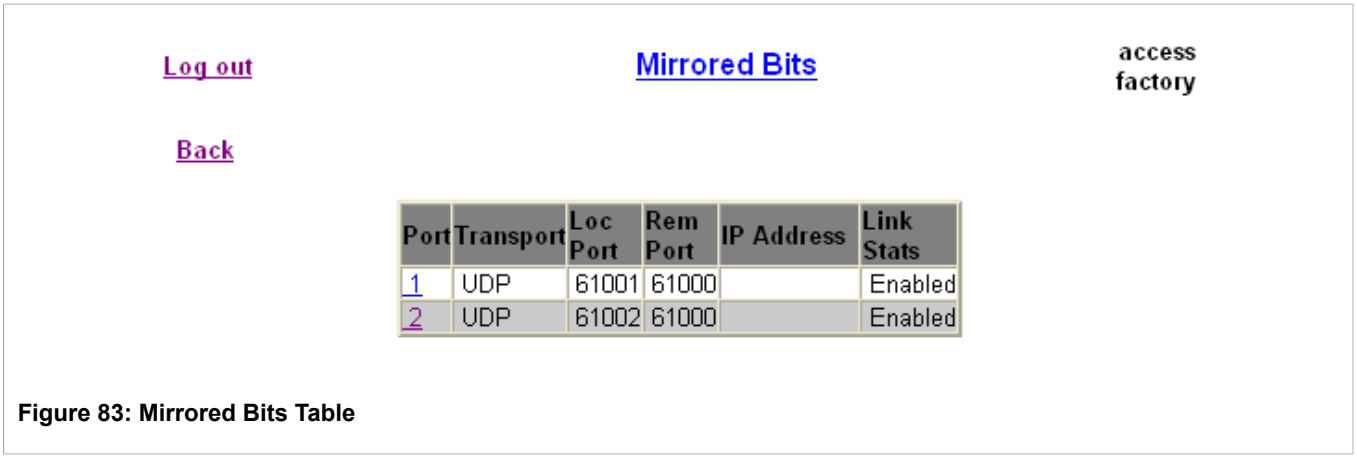


Figure 83: Mirrored Bits Table

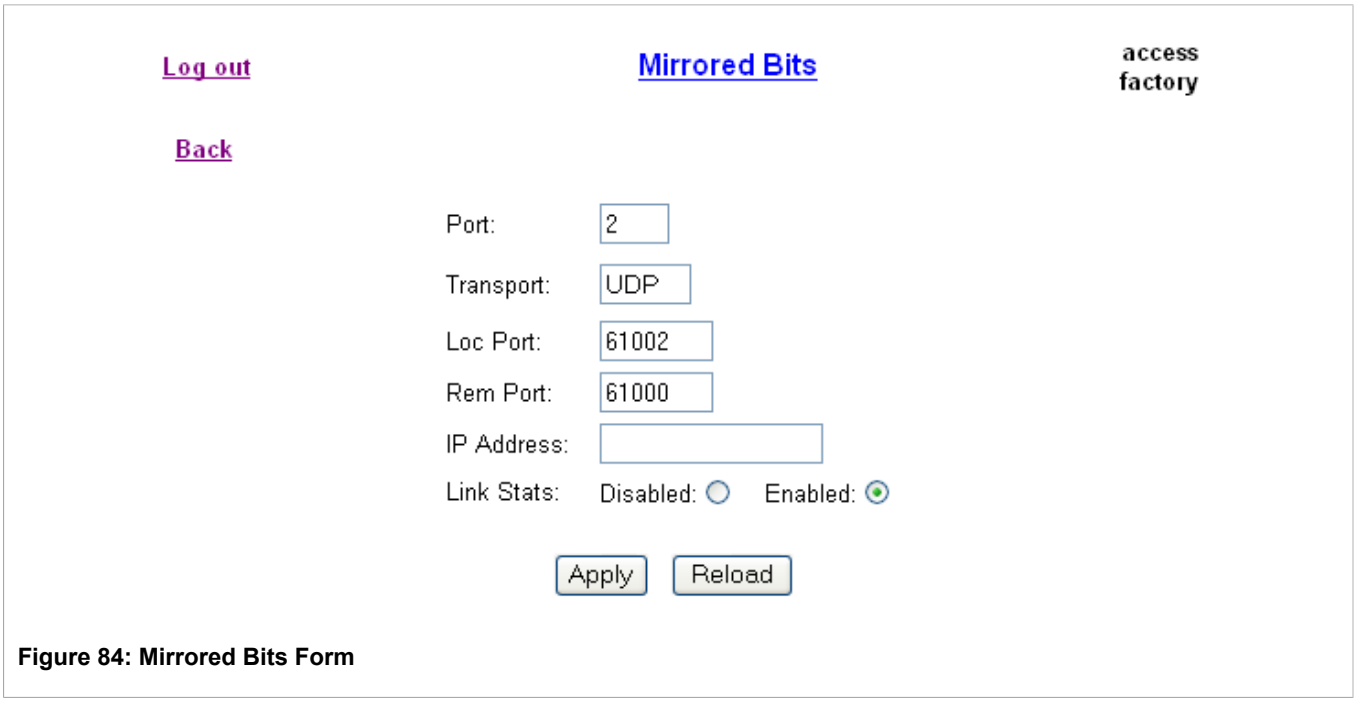


Figure 84: Mirrored Bits Form

Parameter	Description
Port	**Synopsis:** 1 to 4 **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
Transport	**Synopsis:** { TCP, UDP } **Default:** UDP The network transport used to transport Mirrored Bits protocol data over an IP network.
Loc Port	**Synopsis:** 1024 to 65535 **Default:** 61001 The local IP port to use when listening for an incoming connection or UDP data.
Rem Port	**Synopsis:** 1 to 65535 **Default:** 61000 The remote TCP port to use when placing an outgoing connection.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 or { <EMPTY STRING> } Default: For an outgoing TCP connection (client) and UDP transport, this is the remote IP address to communicate with. For an incoming TCP connection (server), the local interface IP address on which to listen for connection requests. An empty string implies the default: the IP address of the management interface. When both outgoing and incoming connections are enabled (client or server), this is the remote IP address to which to place an outgoing TCP connection request or from which to accept an incoming request.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables link statistics collection for this protocol.

Section 3.3.12
TelnetComPort

Log out Telnet Com Port 1 Alarms!

Back

Port	Pack Char	Pack Timer	Pack Size	Flow Control	Call Dir	Loc Port	Rem Port	IP Address	Link Stats
1	Off	10 ms	Maximum	None	In	50001	50000		Enabled

Figure 85: TelnetComPort Table

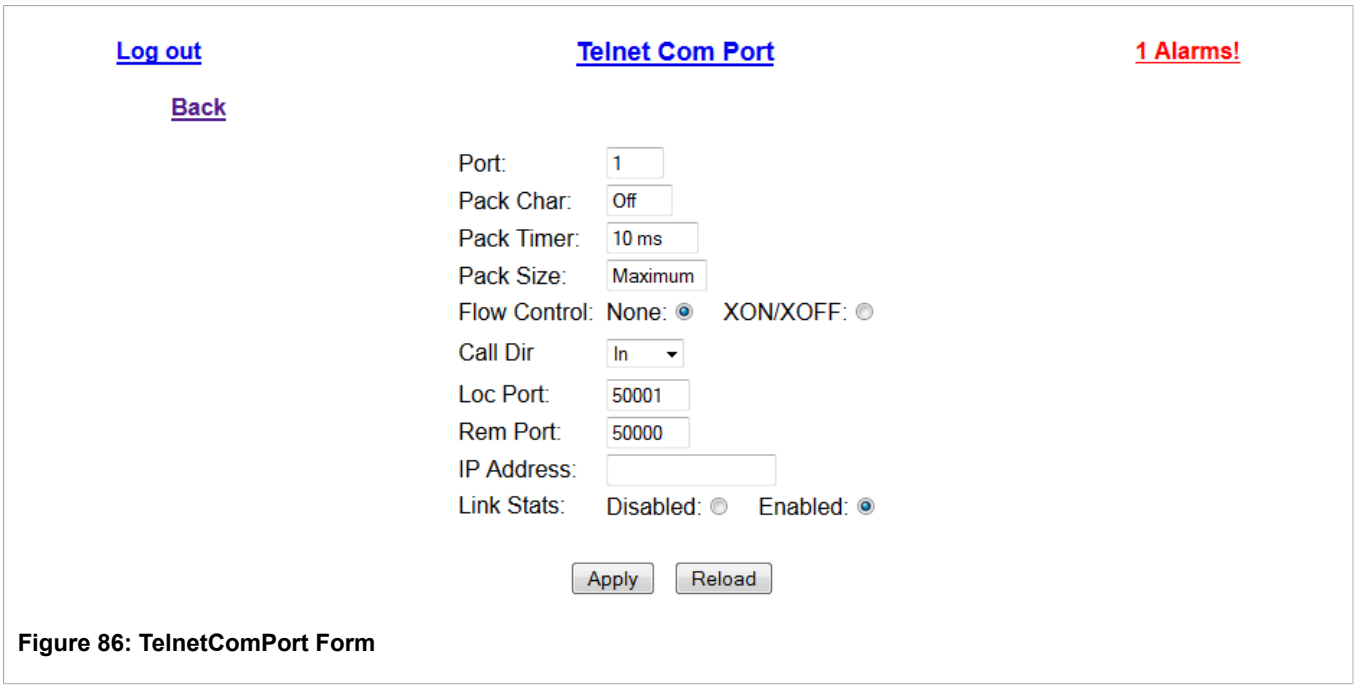


Figure 86: TelnetComPort Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number **Default:** 1 The serial port number as seen on the front plate silkscreen of the RS416.
Pack Char	**Synopsis:** 0 to 255 or { Off } **Default:** Off The character that will be used to force the forwarding of buffered data to the network. If a packetization character is not configured, buffered data will be forwarded based upon the packetization timeout (Pack Timer) parameter.
Pack Timer	**Synopsis:** 1 to 1000 **Default:** 10 ms The delay from the last received character until when data is forwarded. If parameter value is set to be less than 3 ms, there is not guaranty that it will be obeyed. It will be a minimum possible time in which device can react under certain data load.
Pack Size	**Synopsis:** 16 to 1400 or { Maximum } **Default:** Maximum The maximum number of bytes received from serial port to be forwarded.
Flow Control	**Synopsis:** { None, XON/XOFF } **Default:** None The Flowcontrol setting for serial port.
Call Dir	**Synopsis:** { In, Out, Both } **Default:** In The Call direction for TCP Tranport. • Whether to accept an incoming connection or • to place an outgoing connection or • to place outgoing connection and wait for incomming (both directions).
Loc Port	**Synopsis:** 1024 to 65535 **Default:** 50000 The local IP port to use when listening for an incoming connection.

Parameter	Description
Rem Port	**Synopsis:** 1 to 65535 **Default:** 50000 The remote TCP port to use when placing an outgoing connection. This parameter is applicable only to TCP transport.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 or { } **Default:** For direction 'OUT' (client), remote IP address to use when placing an outgoing TCP connection request. For direction 'IN' (server), local interface IP address to listen to the local port for connection request. Empty string can be used for IP address of management interface. For direction 'BOTH' (client or server), remote IP address to use when placing an outgoing TCP connection requestListening interface will be chosen by matching mask. This parameter is applicable only to TCP connections. If the transport protocol is set to UDP, the remote port is configured using the "Remote Hosts" table. For more information, see the Section 3.3.3, “Remote Hosts” section.
Link Stats	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables links statistics collection for this protocol.

Section 3.3.13
Device Addresses

Up to 1024 entries can be created in this table.

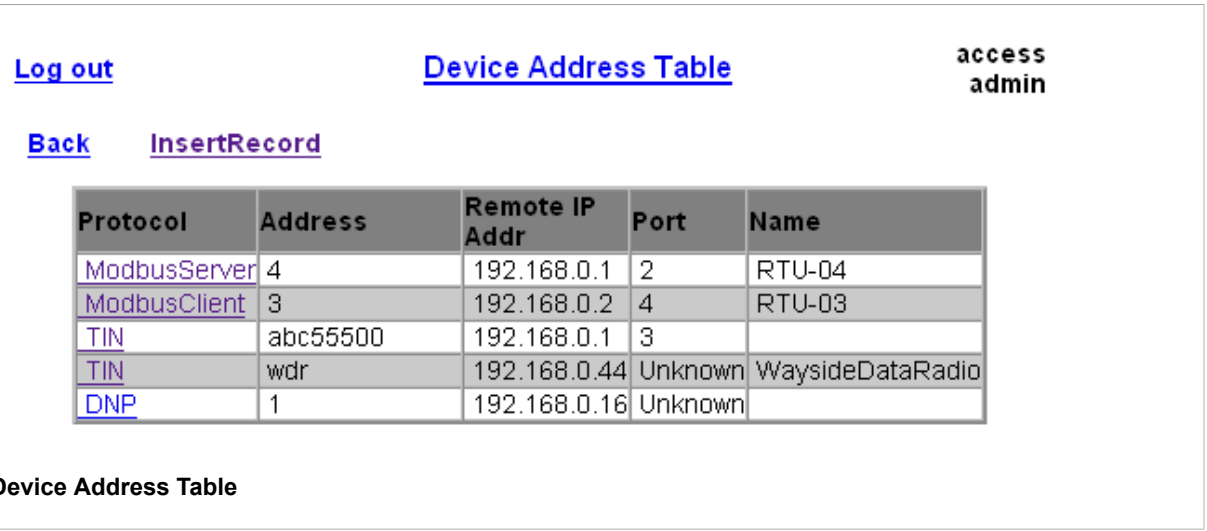


Figure 87: Device Address Table

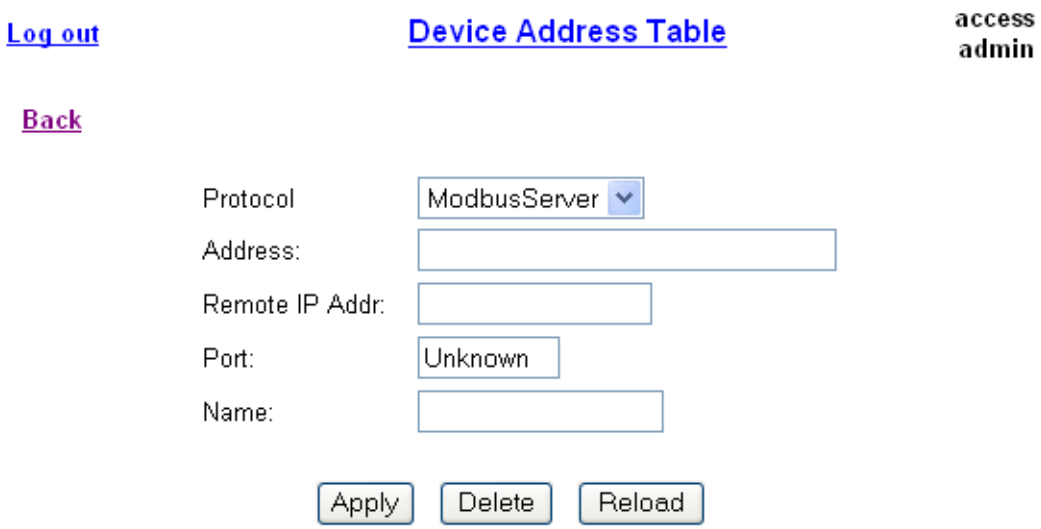


Figure 88: Device Address Form

Parameter	Description
Protocol	**Synopsis:** { ModbusServer, ModbusClient, DNP, WIN, TIN, MicroLok } **Default:** ModbusServer The serial protocol supported on this serial port.
Address	**Synopsis:** Any 31 characters Default: The complete address of a device, which might be either local to the RUGGEDCOM device or remote. A local address is one associated with a device connected to a serial port on this device. The corresponding serial port must be configured to match this address specification. A remote address is the address of a device connected to a serial port on a remote host over an IP network. In this case, "Remote Ip Addr" must also be configured. The format and range of this address field is determined by the protocol: • Modbus: 1 to 244 • MicroLok: 1 to 65535, or 8 to hexadecimal digits ‘1’ to ‘a’ • DNP 3.0: 1 to 65520 • WIN: 6 bits address (0 to 63) • TIN: String 'wdr' for wayside data radio (TIN mode 2), or a 32 bit address (8 digits, expressed in hexadecimal digits '0' through 'f'). An all-zero address is not allowed.
Remote IP Addr	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 Default: The IP address of a remote host where a device with a configured remote address is connected.
Port	**Synopsis:** 1 to maximum port number or {Unknown} **Default:** Unknown The serial port to which a device is attached. If the device with this address is attached to the serial port of a remote host, the value of this parameter is 'Unknown'.
Name	**Synopsis:** Any 16 characters Default: The addressed device name.

Section 3.3.14

Dynamic Device Addresses

This table provides the ability to view the TIN protocol's device addresses from remote locations that were learned dynamically.

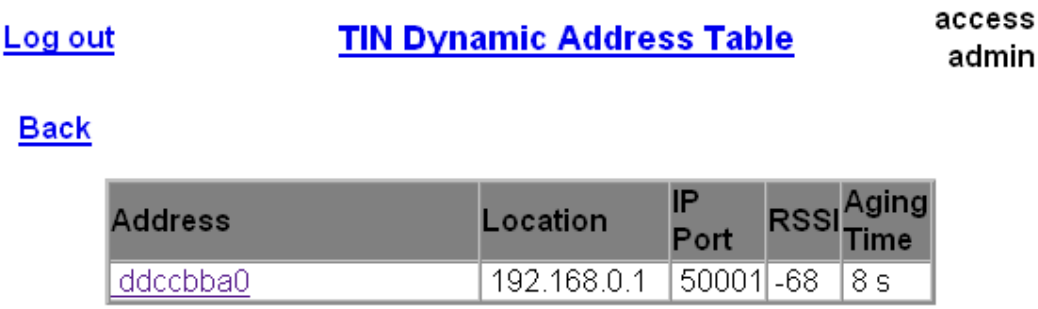


Figure 89: Dynamic Device Address Table

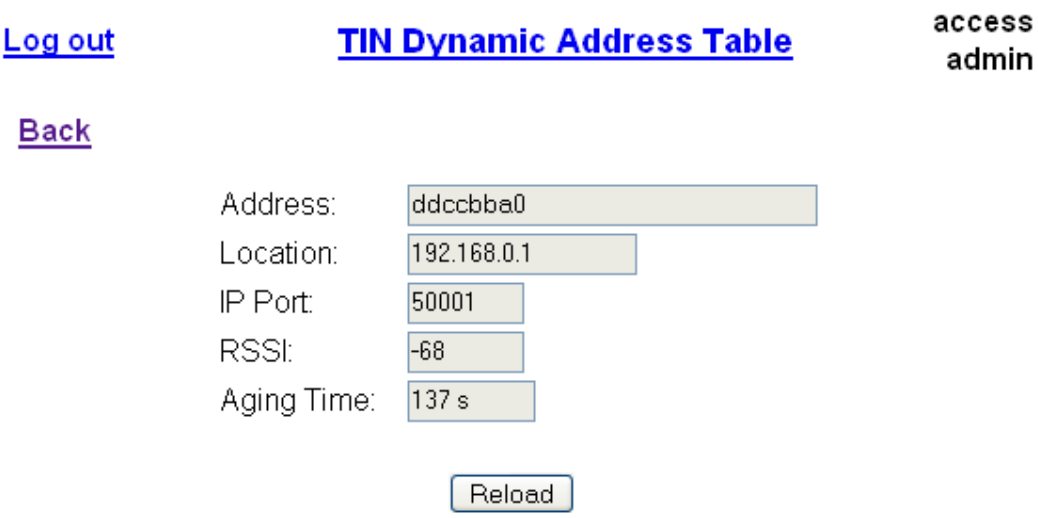


Figure 90: Dynamic Device Address Form

Parameter	Description
Protocol	**Synopsis:** { TIN } The serial protocol supported on this serial port.
Address	**Synopsis:** Any 31 characters The remote device address.
Location	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 The IP Address of the remote host.
IP Port	**Synopsis:** 1 to 65535

Parameter	Description
	The remote port number from which a UDP datagram was received from a remote device, or from which a TCP connection was established.
RSSI	**Synopsis:** -128 to 0 or { N/A } The signal strength indicator received from wayside data radio. N/A for TIN Mode 1.
Aging Time	**Synopsis:** 0 to 1000 The amount of time since the last packet arrived from the device. Once this time exceeds the Aging Timer setting for the protocol, the device will be removed from the table. This value is updated every 10 seconds.

Section 3.4
Serial Statistics

Section 3.4.1
Link Statistics

This table presents detailed statistics for serial links between two devices.

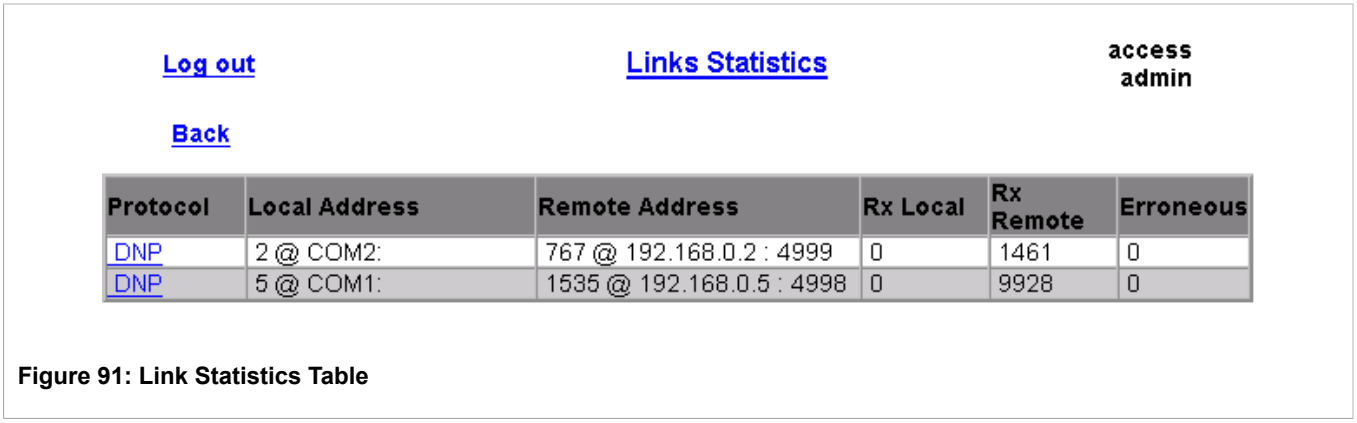


Figure 91: Link Statistics Table

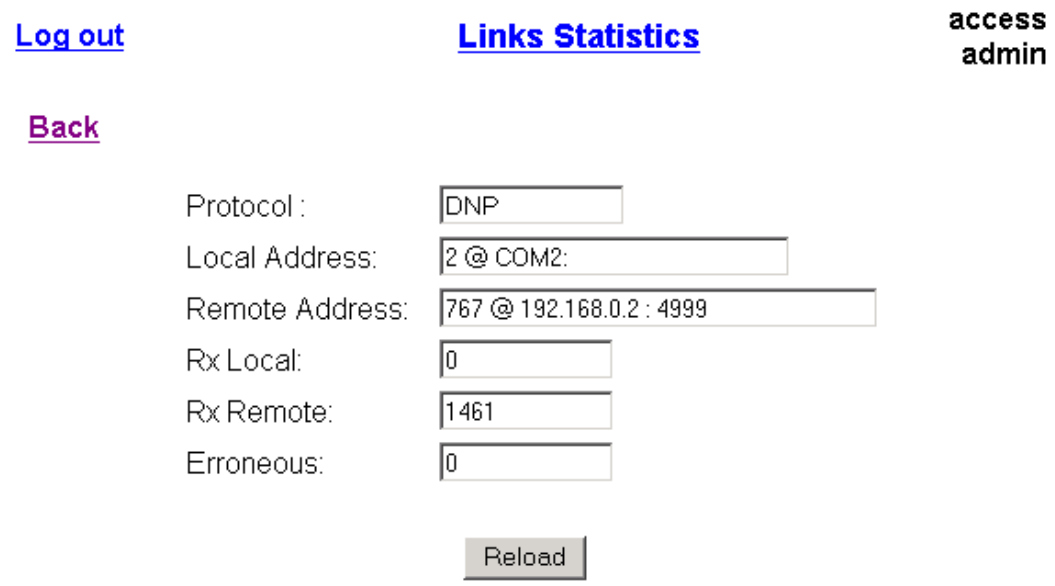


Figure 92: Link Statistics Form

Parameter	Description
Protocol	**Synopsis:** { None, RawSocket, ModbusServer, ModbusClient, DNP, WIN, TIN, MicroLok } The serial protocol supported by devices that create this link.
Local Address	**Synopsis:** Any 27 characters The address of the device connected to the serial port on this device.
Remote Address	**Synopsis:** Any 35 characters The address of the device connected to the remote host's serial port.
Rx Local	**Synopsis:** 0 to 4294967295 The number of packets received from the local address that were forwarded to the remote side.
Rx Remote	**Synopsis:** 0 to 4294967295 The number of packets received from the local address that were forwarded to the local serial port.
Erroneous	**Synopsis:** 0 to 4294967295 The number of erroneous packets received from the remote address.

Section 3.4.2

Connection Statistics

This table presents statistics for all active TCP connections on serial protocols. The statistics are updated once every second.

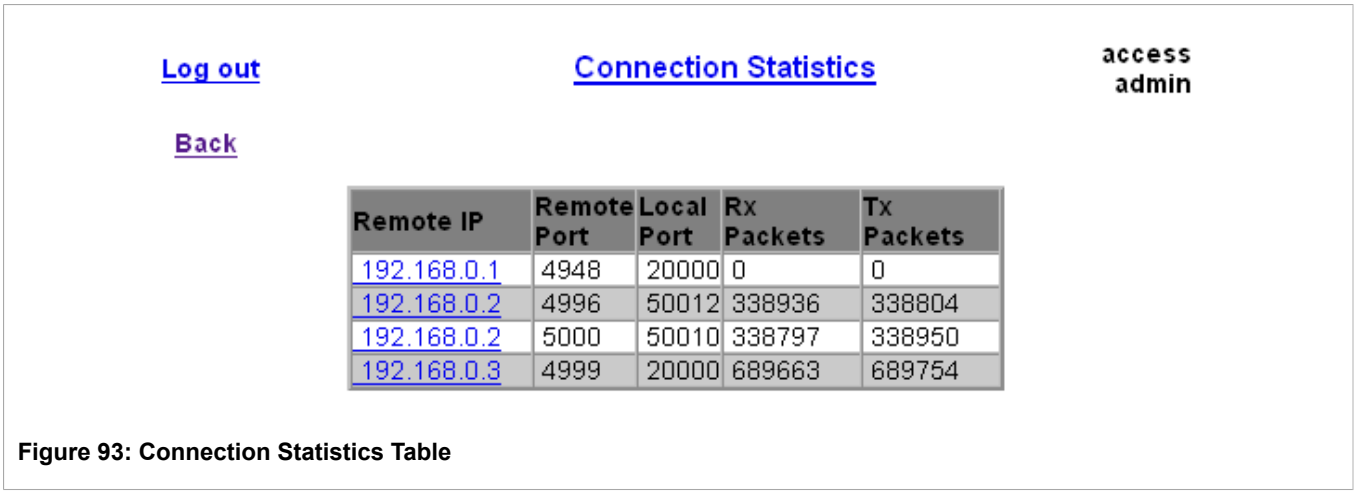


Figure 93: Connection Statistics Table

Parameter	Description
Remote IP	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 The remote IP address of the connection.
Remote Port	**Synopsis:** 0 to 65535 The remote port number of the connection.
Local Port	**Synopsis:** 0 to 65535 The local port number of the connection.
Rx Packets	**Synopsis:** 0 to 4294967295 The number of received packets on the connection.
Tx Packets	**Synopsis:** 0 to 4294967295 The number of packets transmitted on the connection.

Section 3.4.3

Serial Port Statistics

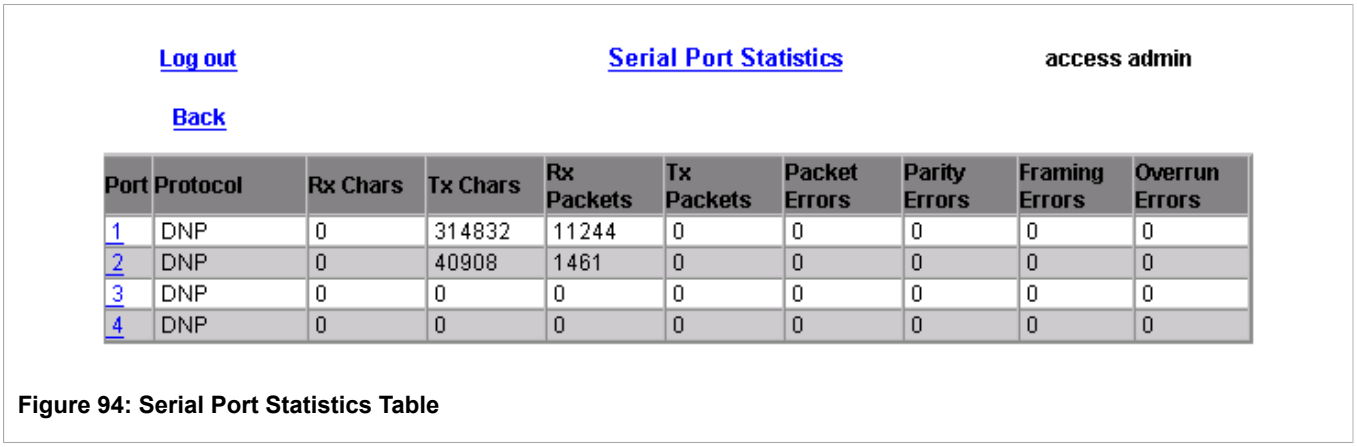

Log out
Serial Port Statistics
access admin
Back
Port Protocol Rx Chars Tx Chars Rx Packets Tx Packets Packet Errors Parity Errors Framing Errors Overrun Errors
1 DNP 0 314832 11244 0 0 0 0 0
2 DNP 0 40908 1461 0 0 0 0 0
3 DNP 0 0 0 0 0 0 0 0
4 DNP 0 0 0 0 0 0 0 0

Figure 94: Serial Port Statistics Table

Parameter	Description
Port	**Synopsis:** 1 to maximum port number

Parameter	Description
	The port number as seen on the front plate silkscreen of the switch.
Protocol	**Synopsis:** Any 15 characters The serial protocol supported on this serial port.
Rx Chars	**Synopsis:** 0 to 4294967295 The number of received characters.
Tx Chars	**Synopsis:** 0 to 4294967295 The number of transmitted characters.
Rx Packets	**Synopsis:** 0 to 4294967295 The number of received packets.
Tx Packets	**Synopsis:** 0 to 4294967295 The number of transmitted packets.
Packet Errors	**Synopsis:** 0 to 4294967295 The number of packets received from this port and discarded (error in protocol, CRC or routing information not found).
Parity Errors	**Synopsis:** 0 to 4294967295 The number of Parity Errors.
Framing Errors	**Synopsis:** 0 to 4294967295 The number of Framing Errors.
Overrun Errors	**Synopsis:** 0 to 4294967295 The number of Overrun Errors.

Section 3.4.4

Clearing Serial Port Statistics

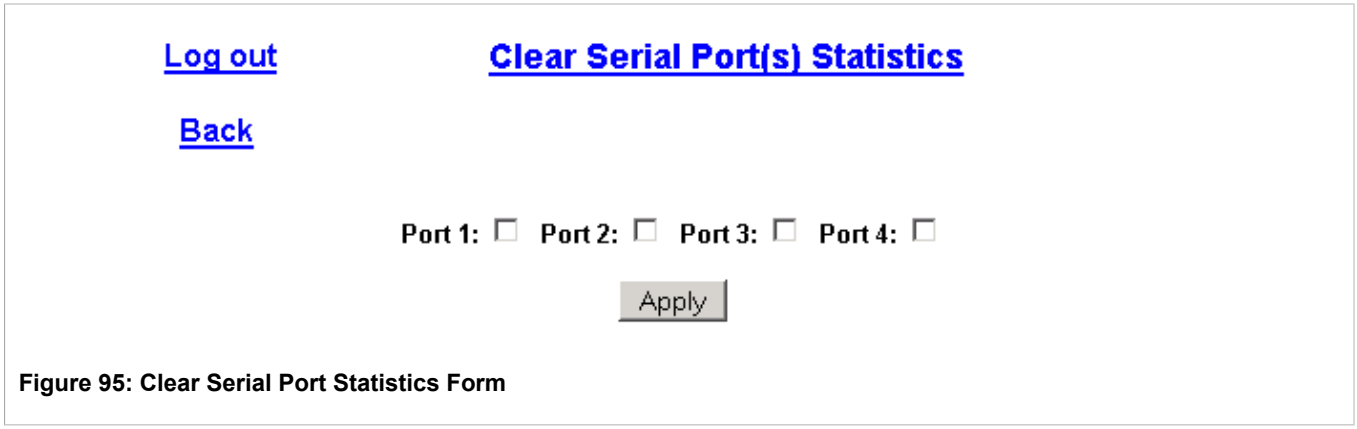


Figure 95: Clear Serial Port Statistics Form

This command clears statistics on one or more serial ports. To clear statistics for one or more ports, check the boxes corresponding to the selected ports and select "Apply".

Section 3.4.5
Resetting Serial Ports

Figure 96: Reset Serial Port(s) Form

To reset one or more ports, check the boxes corresponding to the selected ports and select "Apply".

Section 3.5
Troubleshooting

Problem One

I configured a Serial IP connection to use the TCP transport (using either an inbound or outbound connection) but nothing seems to be happening. What is going on?

Ensure that an Ethernet port link is up.

The peer may not be requesting (accepting) connections. The Connection Statistics Table will display whether the connection is active or not.

The peer may not be sending data. The Connection statistics Table will display the counts of transmitted and received data packets via the IP network.

Watch the connection activity. For a detailed description of the TCP connection activity, turn on tracing at the TRANSPORT level.

Problem Two

My connections (as shown in the Connection Statistics Table) go up and then immediately go down again. What is going on?

If two ports (on the same or different servers) are configured to call the same IP/TCP port in the network, only the first one to call will be successful. All other ports will fail, displaying the attempts as brief periods of connection in the Connection Statistics Table.

Problem Three

My Modbus polling is not working. I am sure that a connection is occurring but my Master reports an error connecting to the device. What is happening?

Are framing, parity or overrun errors reported by either the client or server?

Is the Server Gateway set up for the correct baud, parity and stop bits? Is the RTU online?

Is an adequate response timer configured at the server? Is the master's timeout long enough? Is the master pausing in the middle of transmitting the request? Some versions of the Windows OS have been observed to display this behavior as the load is increased.

Could the IP network be splitting the Modbus message into two TCP segments?

Ultimately, it may be necessary to view the contents of messages transmitted over TCP (by activating tracing at the IP level) or by viewing messages at the serial port level (See the section on tracing at the SERIAL level.) Start by tracing at the client side, ensuring that it is receiving and forwarding the request over IP. Then, if need be, trace at the server side to ensure that it is receiving the request and forwarding to the RTU. Verify that the RTU is responding properly.

Problem Four

How do I get figures (like those presented earlier in the chapter) for my own analysis?

Activating tracing at the IP level and serial port level. The trace package displays timestamps, packet sizes, message directions and timeout event occurrences.

4 Ethernet Ports

ROS Ethernet port control provides the following features:

- Configuring port physical parameters.
- Configuring link alarms/traps for the port.
- Configuring port rate limiting.
- Using Port Mirroring.
- Cable Diagnostics.
- Viewing port status.
- Resetting all or some ports.
- Using Link-Fault-Indication (LFI).

Section 4.1

Controller Protection Through Link-Fault-Indication (LFI)

Modern industrial controllers often feature backup Ethernet ports used in the event of a link failure. When these interfaces are supported by media (such as fiber) that employ separate transmit and receive paths, the interface can be vulnerable to failures that occur in only one of the two paths.

Refer to the following figure. While the link between switch A and the controller functions normally, the controller holds the backup link down. Switch B learns that it must forward frames towards switch A in order to reach the controller.

Unfortunately, if the transmission path from the controller to switch A fails, switch A will still generate link signals to the controller. The controller will still detect link to switch A and will not fail over to the backup port.

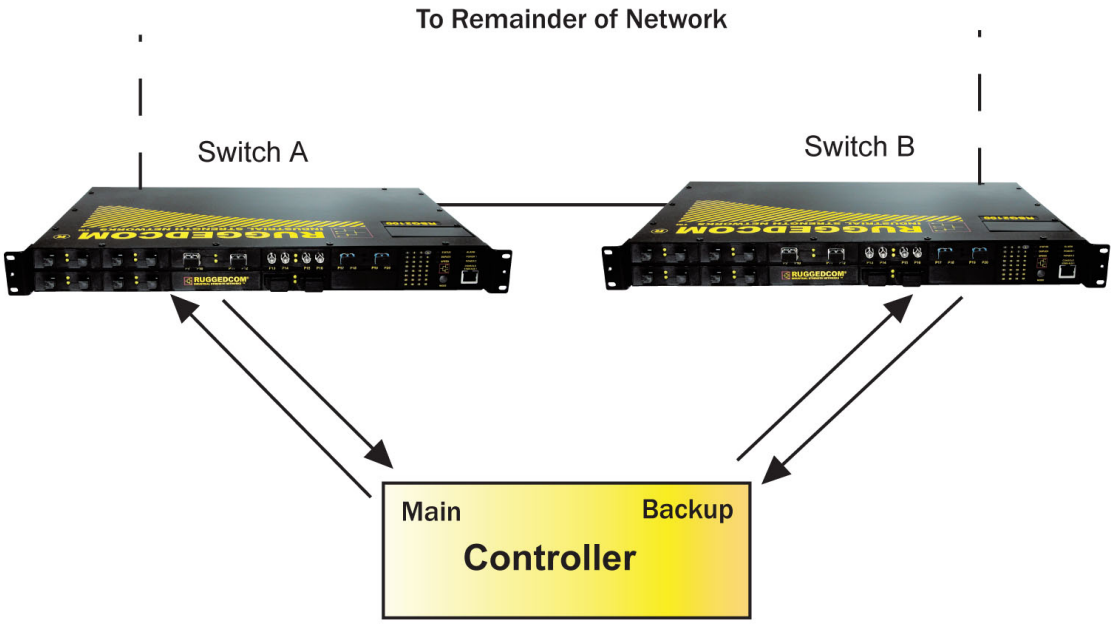


Figure 97: Controller Protection Through LFI

To overcome this problem, there should be a way of notifying the link partner in case a link integrity signal stopped being received from it. Such a way natively exists in some link media but not in others:

- *Auto-Negotiating links (100Base-TX,1000Base-T,1000Base-X)* - auto-negotiation built-in feature (a special flag called Remote Fault Indication is set in the transmitted auto-negotiation signal)
- *100Base-FX links* - Far–End-Fault-Indication (FEFI) is a standard feature defined by the IEEE 802.3 standard for this link type. The feature includes:
  - Transmitting FEFI - transmitting modified link integrity signal in case a link failure is detected, i.e. no link signal is received from the link partner.
  - Detecting FEFI - indicating link loss in case FEFI signal is received from the link partner.
- *10Base-FL links* - no standard support

As one can see from the above, 10Base-FL links have no native link partner notification mechanism. Also, FEFI support in 100Base-FX links is optional according to the IEEE 802.3 standard, which means that some link partners may not support it.

Siemens offers an advanced Link-Fault-Indication (LFI) feature for the links where no native link partner notification mechanism is available. With the LFI enabled, the device bases generation of a link integrity signal upon its reception of a link signal. In the diagram above, if switch A fails to receive a link signal from the controller, it will stop generating a link signal. The controller will detect the link failure and switch to the backup port.

The switch can also be configured to flush the MAC address table for the controller port (see MAC Address Tables section). Frames destined for the controller will be flooded to switch B where they will be forwarded to the controller (after the controller transmits its first frame).

NOTE
If both link partners are capable of the LFI, it MUST NOT be enabled on both sides of the link. If it is enabled on both sides, the link will never be established because each side will permanently wait for its partner to transmit a link signal.

Section 4.2
Ethernet Ports Configuration and Status

The Ethernet Ports menu is accessible from the main menu.

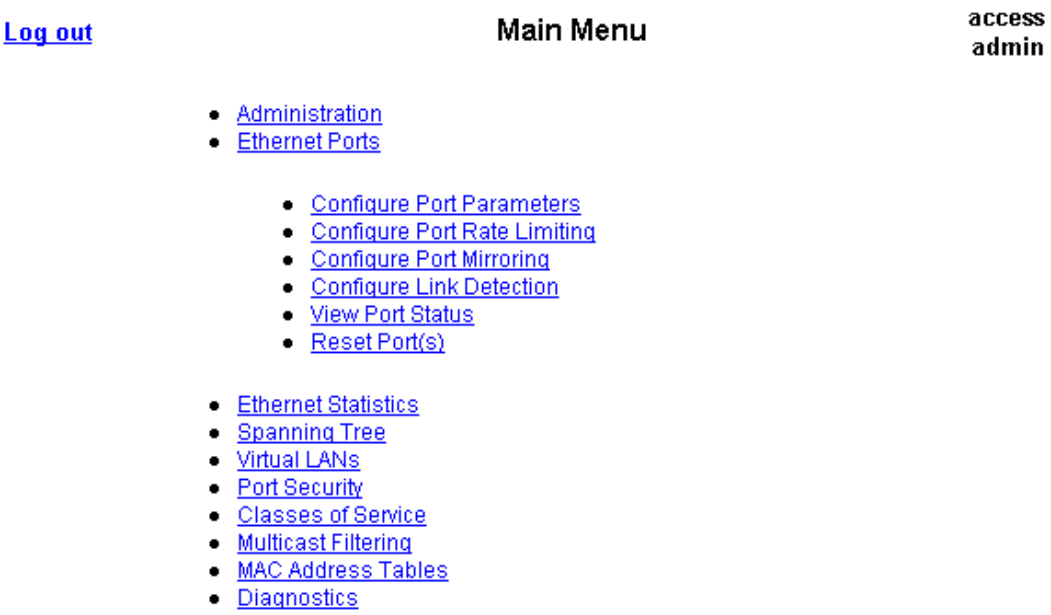


Figure 98: Ethernet Ports Menu

Section 4.2.1
Port Parameters

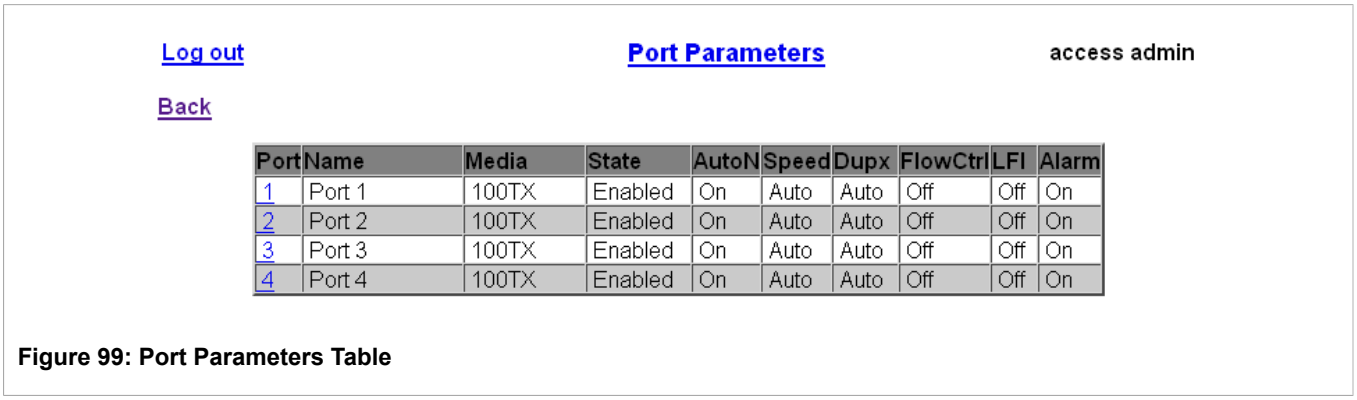

Log out
Port Parameters
access admin
Back
Port Name Media State AutoN Speed Dupx FlowCtrl LFI Alarm
1 Port 1 100TX Enabled On Auto Auto Off Off On
2 Port 2 100TX Enabled On Auto Auto Off Off On
3 Port 3 100TX Enabled On Auto Auto Off Off On
4 Port 4 100TX Enabled On Auto Auto Off Off On

Figure 99: Port Parameters Table

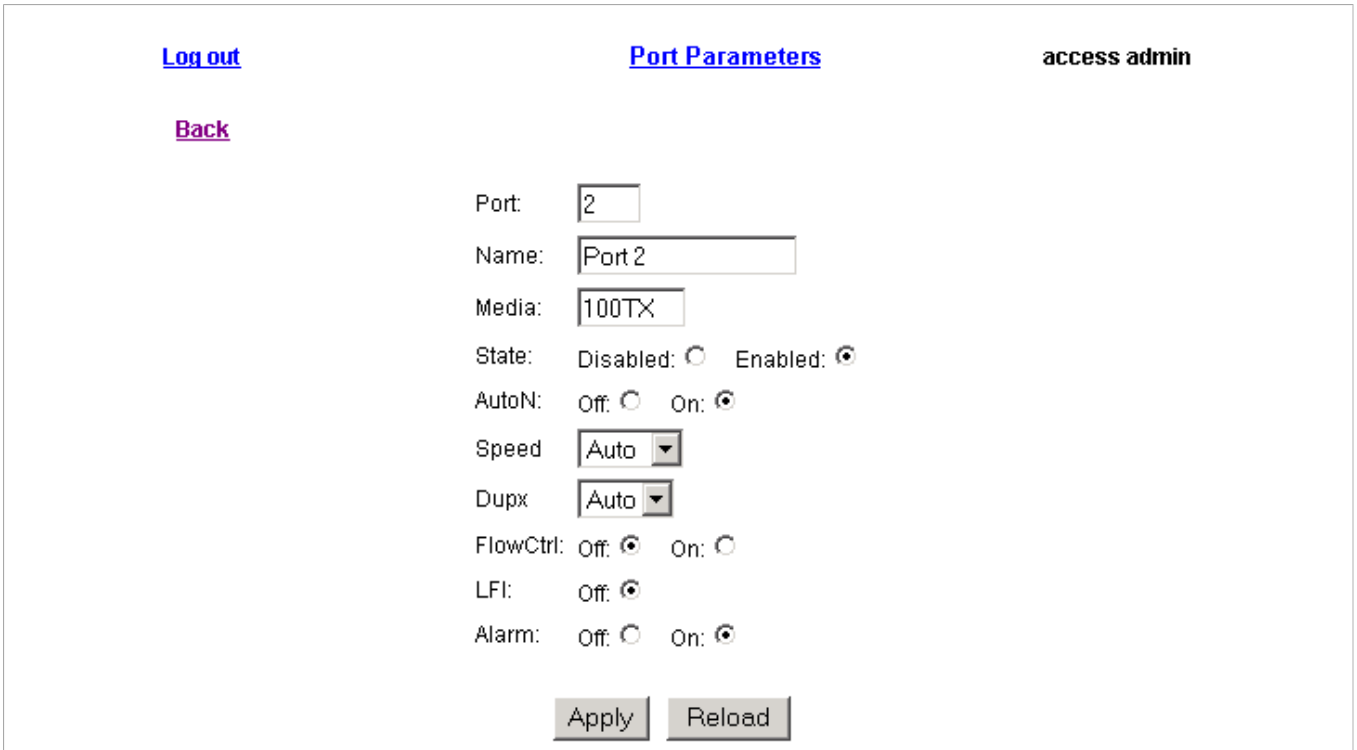


Figure 100: Port Parameters Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number **Default:** 0 The port number as seen on the front plate silkscreen of the switch.
Name	**Synopsis:** Any 15 characters **Default:** Not installed A descriptive name that may be used to identify the device connected to that port.
Media	**Synopsis:** { 100TX, 10FL, 100FX, 1000X, 1000T, 802.11g, EoVDSL, 100TX Only, 10FL/100SX, 10GX }

Parameter	Description
	The type of the port's media.
State	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Disabling a port will prevent all frames from being sent and received on that port. Also, when disabled link integrity pulses are not sent so that the link/activity LED will never be lit. You may want to disable a port for troubleshooting or to secure it from unauthorized connections. **NOTE** *Disabling a port whose media type is set to 802.11 disables the corresponding wireless module.*
AutoN	**Synopsis:** { Off, On } **Default:** On Enable or disable IEEE 802.3 auto-negotiation. Enabling auto-negotiation results in speed and duplex mode being negotiated upon link detection; both end devices must be auto-negotiation compliant for the best possible results. 10Mbps and 100Mbps fiber optic media do not support auto-negotiation so these media must be explicitly configured to either half or full-duplex mode. Full-duplex operation requires both ends to be configured as such or else severe frame loss will occur during heavy network traffic.
Speed	**Synopsis:** { Auto, 10M, 100M, 1G } **Default:** Auto Speed (in Megabit-per-second or Gigabit-per-second). If auto-negotiation is enabled, this is the speed capability advertised by the auto-negotiation process. If auto-negotiation is disabled, the port is set to this speed. AUTO means advertise all supported speed modes.
Dupx	**Synopsis:** { Auto, Half, Full } **Default:** Auto Duplex mode. If auto-negotiation is enabled, this is the duplex capability advertised by the auto-negotiation process. If auto-negotiation is disabled, the port is set to this duplex mode. AUTO means advertise all supported duplex modes.
Flow Control	**Synopsis:** { Off, On } **Default:** Off Flow Control is useful for preventing frame loss during times of severe network traffic. Examples of this include multiple source ports sending to a single destination port or a higher-speed port bursting to a lower-speed port. When the port is in half-duplex mode, this is accomplished using 'backpressure' whereby the switch simulates collisions, causing the sending device to retry transmissions according to the Ethernet back-off algorithm. When the port is in full-duplex mode, this is accomplished using PAUSE frames, which cause the sending device to stop transmitting for a certain period of time.
LFI	**Synopsis:** { Off, On } **Default:** Off Enabling Link-Fault-Indication (LFI) inhibits transmission of the link integrity signal when the receiving link has failed. This enables the device at far end to detect link failure under all circumstances. **NOTE** *This feature must not be enabled at both ends of a link.*
Alarm	**Synopsis:** { On, Off } **Default:** On

Parameter	Description
	Disabling link state alarms will prevent alarms and LinkUp and LinkDown SNMP traps from being sent for that port.

NOTE

If one end of the link is fixed to a specific speed and duplex type and the peer auto-negotiates, there is a strong possibility that the link will either fail to raise, or raise with the wrong settings on the auto-negotiating side. The auto-negotiating peer will fall back to half-duplex operation, even when the fixed side is full duplex. Full-duplex operation requires that both ends are configured as such or else severe frame loss will occur during heavy network traffic. At lower traffic volumes the link may display few if any errors As the traffic volume rises the fixed negotiation side will begin to experience dropped packets while the auto-negotiating side will experience excessive collisions. Ultimately, as traffic load approaches 100% the link will become entirely unusable. These problems can be avoided by always configuring ports to the appropriate fixed values.

Section 4.2.2

Port Rate Limiting

Log out

Port Rate Limiting

access
admin

Back

Port	Ingress Limit	Ingress Frames	Egress Limit
1	1000 Kbps	Broadcast	Disabled
2	1000 Kbps	Broadcast	Disabled
3	1000 Kbps	Broadcast	Disabled
4	1000 Kbps	Broadcast	Disabled
5	1000 Kbps	Broadcast	Disabled
6	1000 Kbps	Broadcast	Disabled
7	1000 Kbps	Broadcast	Disabled
8	1000 Kbps	Broadcast	Disabled
9	1000 Kbps	Broadcast	Disabled
10	1000 Kbps	Broadcast	Disabled

Figure 101: Port Rate Limiting Table

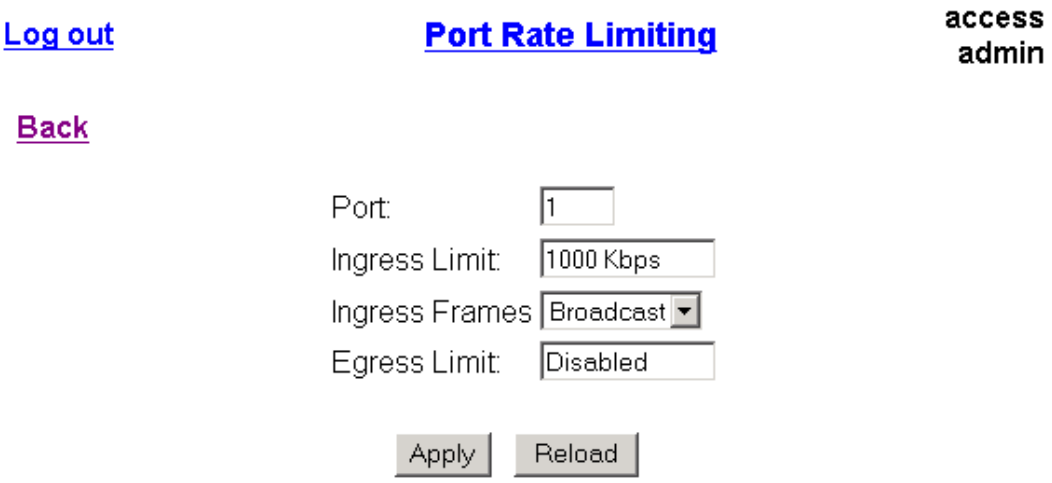


Figure 102: Port Rate Limiting Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
Ingress Limit	Synopsis: 62 to 256000 Kbps or { Disabled } Default: 1000 Kbps The maximum rate above which received frames (of the type described by the ingress frames parameter) will be discarded by the switch. Note that this guarantees an upper boundary only. The observed rate threshold may be lower.
Ingress Frames	**Synopsis:** { Broadcast, Multicast, Mcast&FloodUcast, All } **Default:** Broadcast This parameter specifies the types of frames to be rate-limited on this port. It applies only to received frames: Broadcast - only broadcast frames. Multicast - multicast (including broadcast) frames. Mcast&FloodUcast - multicast (including broadcast) and flooded unicast frames. All - all (multicast, broadcast and unicast) frames.
Egress Limit	**Synopsis:** 62 to 256000 Kbps or { Disabled } **Default:** Disabled The maximum rate at which the switch will transmit (multicast, broadcast and unicast) frames on this port. The switch will discard frames in order to meet this rate if required.

Section 4.2.3
Port Mirroring

Port mirroring is a troubleshooting tool that copies, or mirrors, all traffic received or transmitted on a designated port to another mirror port. If a protocol analyzer were attached to the target port, the traffic stream of valid frames on any source port is made available for analysis.

Select a target port that has a higher speed than the source port. Mirroring a 100 Mbps port onto a 10 Mbps port may result in an improperly mirrored stream.

Frames will be dropped if the full-duplex rate of frames on the source port exceeds the transmission speed of the target port. Since both transmitted and received frames on the source port are mirrored to the target port, frames will be discarded if the sum traffic exceeds the target port's transmission rate. This problem reaches its extreme in the case where traffic on a 100 Mbps full-duplex port is mirrored onto a 10 Mbps half-duplex port.

NOTE
Invalid frames received on the source port will not be mirrored. These include CRC errors, oversize and undersize packets, fragments, jabbers, collisions, late collisions and dropped events).

Section 4.2.3.1
Port Mirroring Limitations

- Traffic will be mirrored onto the target port only if the target port is a member of the same VLANs as the source port.
- The target port may sometimes incorrectly show the VLAN tagged/untagged format of the mirrored frames.
- Network management frames (such as STP, GVRP etc.) may not be mirrored.
- Switch management frames generated by the switch (such as Telnet, HTTP, SNMP etc.) may not be mirrored.

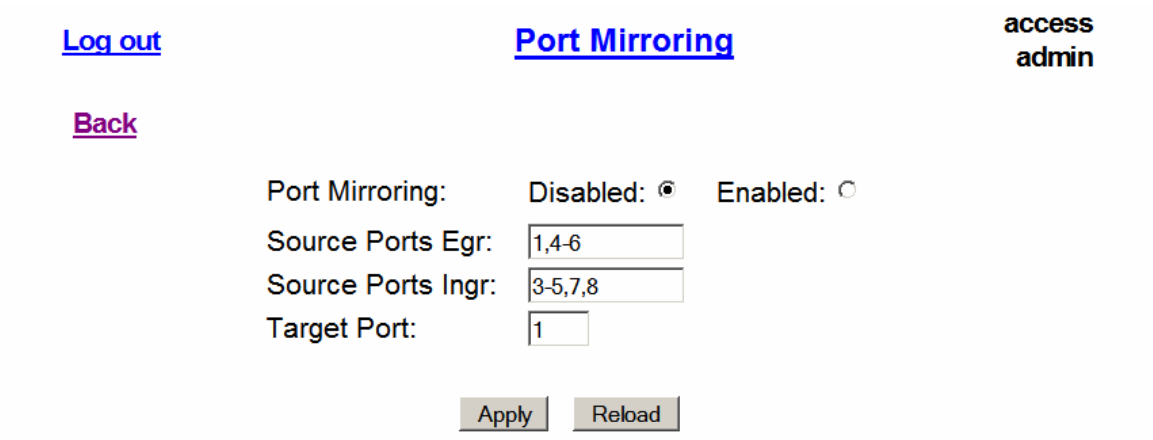


Figure 103: Port Mirroring Form

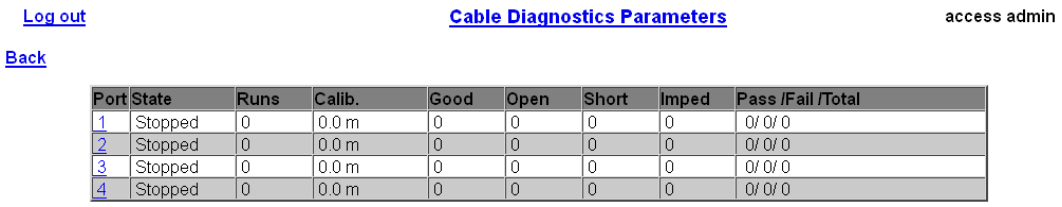
Parameter	Description
Port Mirroring	**Synopsis:** { Disabled, Enabled } **Default:** Disabled Enabling port mirroring causes all frames received and transmitted by the source port(s) to be transmitted out of the target port.
Source Ports Egr	**Synopsis:** Any combination of numbers valid for this parameter **Default:** None Ethernet ports whose egress traffic is to be mirrored to the target port.
Source Ports Ingr	**Synopsis:** Any combination of numbers valid for this parameter **Default:** None

Parameter	Description
	Ethernet ports whose ingress traffic is to be mirrored to the target port.
Target Port	**Synopsis:** 1 to maximum port number **Default:** 1 The port to which selected traffic is mirrored. A monitoring device should be connected to the target port.

Section 4.2.4
Cable Diagnostics

ROS is able to perform cable diagnostics per Ethernet port and to view the results.

WARNING!
When cable diagnostics are performed on a port, any established network link on the port will be dropped and normal network traffic will not be able to pass through either the Port Under Test or the Partner Port. Please be aware of the potential network interruption that could be triggered by running cable diagnostics. After the cable diagnostics finish, the original network port settings for both the Port Under Test and the Partner Port are restored along with any established link.



Port	State	Runs	Calib.	Good	Open	Short	Imped	Pass /Fail /Total
1	Stopped	0	0.0 m	0	0	0	0	0/ 0/ 0
2	Stopped	0	0.0 m	0	0	0	0	0/ 0/ 0
3	Stopped	0	0.0 m	0	0	0	0	0/ 0/ 0
4	Stopped	0	0.0 m	0	0	0	0	0/ 0/ 0

Figure 104: Cable Diagnostics Table

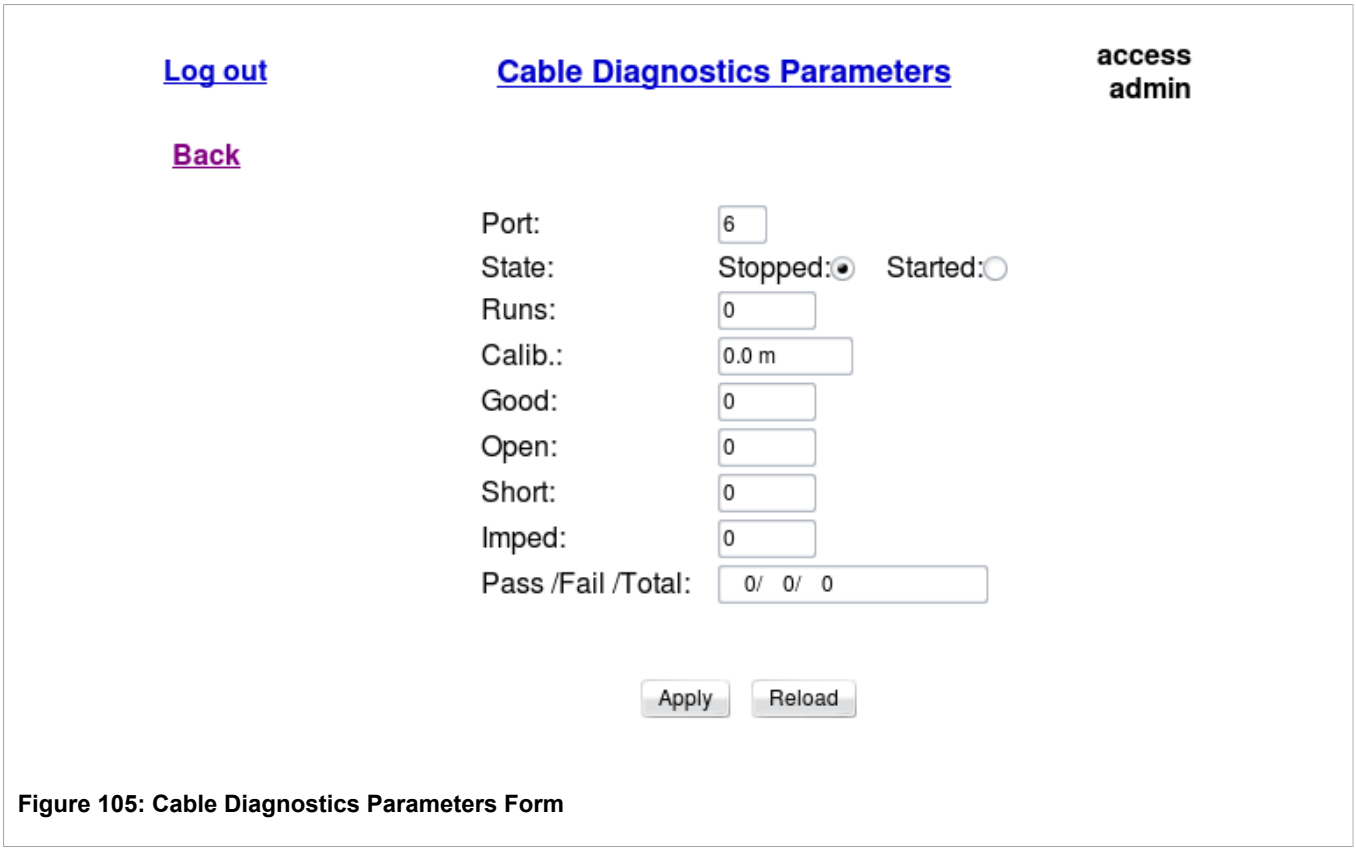


Figure 105: Cable Diagnostics Parameters Form

The Figure 104, “Cable Diagnostics Table” screen, pictured above, lists the current value of the following parameters for all Ethernet ports. Clicking on a port number in the table brings up the Figure 105, “Cable Diagnostics Parameters Form” for the corresponding port. This form can be used to set certain of the cable diagnostic parameters for the port, as indicated below:

Parameter	Description
Port	**Synopsis:** 1 to X The port number as seen on the front plate silkscreen of the switch.
State	Started, Stopped or N/A Start or stop cable diagnostics on the selected port. If a port does not support cable diagnostics, State will be reported as N/A.
Runs	**Synopsis:** 0 to 65535 The total number of times that cable diagnostics are to be performed on the selected port. If set to 0, cable diagnostics will be performed until diagnostics are stopped explicitly.
Calib.	**Synopsis:** -100.0 m to 100.0 m The calibration value can be used to adjust the estimated distance to the fault. Refer to Section 4.2.4.3, “Calibrating Estimated Distance To Fault” for details on setting this parameter.
Good	**Synopsis:** 0 to 65535 The number of times that GOOD TERMINATION (no fault) has been detected on the cable pairs of the selected port.
Open:	**Synopsis:** 0 to 65535 The number of times that OPEN has been detected on the cable pairs of the selected port.

Parameter	Description
Short	**Synopsis:** 0 to 65535 The number of times that SHORT has been detected on the cable pairs of the selected port.
Imped	**Synopsis:** 0 to 65535 The number of times that IMPEDANCE MISMATCH has been detected on the cable pairs of the selected port.
Pass/Fail/Total:	**Synopsis:** 0 to 65535 / 0 to 65535 / 0 to 65535 This field summarizes the results of the cable diagnostics performed so far: • Pass - the number of times that cable diagnostics were completed successfully on the selected port. • Fail - the number of times that cable diagnostics failed on the selected port. • Total - the total number of times that cable diagnostics have been attempted on the selected port.

Section 4.2.4.1
Running Cable Diagnostics

To start cable diagnostics on a port:

1. Connect a Category 5 or better quality cable to the port under test (PUT).
2. Connect the other end of the cable to a similar network port. For example, connect 100BASE-T port to a 100BASE-T port, 1000BASE-T port to a 1000BASE-T port.
3. Configure the PUT's "Runs" count.
4. Configure the PUT's cable diagnostics State to "Started".

To stop cable diagnostics on a port:

1. Configure the PUT's cable diagnostics state to "Stopped". Diagnostics may be stopped at any point. If a stop is issued in the middle of a diagnostics run, it will nevertheless run to completion and the results will be updated.

NOTE
Both the port under test (PUT) or partner port (PT) can be configured to be either in Enabled mode with auto-negotiation or in Disabled mode. Other modes may interfere with the cable diagnostics procedure and are not recommended.

Section 4.2.4.2
Interpreting Cable Diagnostics Results

Four different conditions are reported for the state of a cable under examination:

- Good - No fault is detected on the tested cable.
- Open - Opened cable pair(s) is/are detected on the tested cable.
- Short - Short cable pair(s) is/are detected on the tested cable.
- Imped - Impedance Mismatch is detected on the tested cable.

The corresponding counts for each of these status conditions indicates the number of occurrences of each type of fault. For a typical "no fault" Category 5 cable plugged into a 100BASE-T port, 'Good' will be incremented by

two after every run of cable diagnostics, once for each cable pair used by a 100BASE-T port. Note that for a 1000BASE-T port, four cable pairs will be tested and so 'Good' will be incremented by four after every successful run.

For a fault condition, an estimated distance to the fault will be calculated and recorded in the system log. For detailed information about which cable pair has been detected to have experienced which type of fault and the corresponding distance to the fault, please refer to the system log file.

NOTE

The "Runs" parameter cannot be changed while cable diagnostics are running on a port. In order to change the value, stop the diagnostic run on the port, change the "Runs" parameter, and restart diagnostics.

On ports that do not support cable diagnostics, "N/A" will be shown as the cable diagnostics state and any settings made to the "Runs" and "Calibration" fields will be discarded.

Section 4.2.4.3

Calibrating Estimated Distance To Fault

Take the following steps to calibrate the "Calib" parameter (the estimated distance to fault):

1. Pick a particular port for which calibration is needed.
2. Connect an Ethernet cable with a known length (e.g. 50m) to the port.
3. Do not connect the other end of the cable to any link partner.
4. Run cable diagnostics a few times on the port. OPEN fault should be detected.
5. Find the average distance to the OPEN fault recorded in the log and compare it to the known length of the cable. The difference can be used as the calibration value.
6. Enter the calibration value and run cable diagnostics a few more times.
7. The distance to the OPEN fault should now be at a similar distance to the actual cable length.
8. The distance to the fault for the selected port is now calibrated.

Section 4.2.5

Link Detection Options

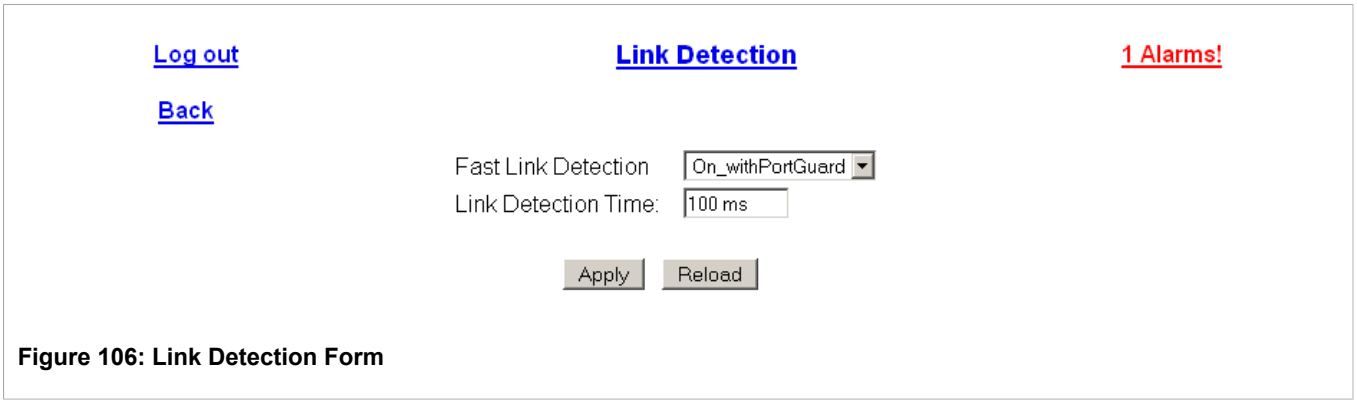


Figure 106: Link Detection Form

Parameter	Description
Fast Link Detection	**Synopsis:** { Off, On, On_withPortGuard } **Default:** On_withPortGuard This parameter provides system protection against a faulty end device generating an improper link integrity signal. When a faulty end device or a mismatched fiber port is connected to the unit, a large number of continuous link state changes can be reported in a short period of time. This high rate of link state changes can render the system unresponsive. **Three different settings are available for this parameter:** • *ON_withPortGuard* - This is the recommended setting. With this setting, an extended period (> two minutes) of excessive link state changes reported by a port prompts the Port Guard feature to permanently disable Fast Link Detection on the and raises an alarm. By disabling Fast Link Detection on the port, excessive link state changes can no longer consume a substantial amount of system resources. However, note that if Fast Link Detection is disabled, the port will need a longer time to detect a link failure. If the port is part of a spanning tree, this could result in a longer network recovery time, of up to two seconds. After Port Guard disables Fast Link Detection on a particular port, you can re-enable it by clearing the alarm. • *ON* - In special cases where prolonged and frequent link state change constitutes legitimate link operation, this setting prevents the system from disabling Fast Link Detection on the port. If excessive link state changes persist for more than two minutes on a particular port, an alarm is generated to warn about the observed bouncing link. If the condition of excessive link state changes is resolved later on, the alarm is cleared automatically. Because this option does not disable Fast Link Detection, a persistent bouncing link could affect the response time of the system. This setting should be used with caution. • *OFF* - Turning this parameter OFF completely disables Fast Link Detection. The switch will need a longer time to detect a link failure. This will result in a longer network recovery time of up to two seconds. Only use this option if if fast link failure detection is not needed.
Link Detection Time	**Synopsis:** 100 ms to 1000 ms **Default:** 100 ms Determines the time that the link has to continuously stay up before the “link up” decision is made by the device. The device performs Ethernet link detection de-bouncing to avoid multiple responses to an occasional link bouncing event (for example, when a cable makes intermittent contact while being plugged in or unplugged).

NOTE
When Fast Link Detection is enabled, the system prevents link state change processing from consuming all available CPU resources. However, if Port Guard is not used, it is possible for almost all available CPU time to be consumed by frequent link state changes, which could have a negative impact on overall system responsiveness.

Section 4.2.6
Port Status

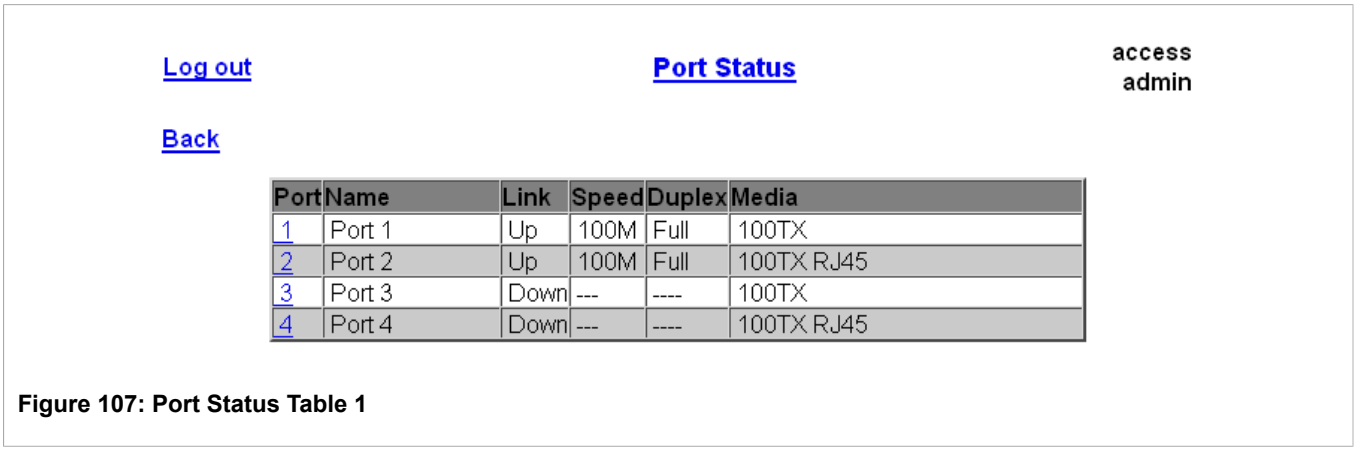

Log out
Port Status
access
admin
Back
Port Name Link Speed Duplex Media
1 Port 1 Up 100M Full 100TX
2 Port 2 Up 100M Full 100TX RJ45
3 Port 3 Down --- ---- 100TX
4 Port 4 Down --- ---- 100TX RJ45

Figure 107: Port Status Table 1

Parameter	Description
Port	**Synopsis:** 1 to maximum port number The port for which status is provided.
Name	**Synopsis:** Any 15 characters A descriptive name that may be used to identify the device connected to that port.
Link	**Synopsis:** { ----, ----, Down, Up } The port's link status.
Speed	**Synopsis:** { ---, 10, 100, 1000 } The port's current speed.
Duplex	**Synopsis:** { ----, Half, Full } The port's current duplex status.
Media Type	**Synopsis:** Any 31 characters Provides user with the description of installed media type on the port for modular products. Please note that fiber media may be either Single Mode(SM), Multi Mode(MM), may be Short Distance, Long Distance or Very Long Distance with connectors like LC, SC, ST, MTRJ etc. For the modules with SFP/GBICs, media description is displayed as per SFF-8472 specification, if transceiver is plugged into the module, e.g., 10/100/1000TX RJ45, 100FX SM SC, 10FX MM ST, 1000SX SFP LC S SL M5

Section 4.2.7
Resetting Ports

This command performs a reset of the specified Ethernet ports. This action is useful for forcing re-negotiation of speed and duplex mode or in situations where the link partner has latched into an inappropriate state.

Section 4.3
Troubleshooting

Problem One

One of my links seems to be fine at low traffic levels, but starts to fail as traffic rates increase.

One of my links pings OK but has problems with FTP/SQL/HTTP/…

A possible cause of intermittent operation is that of a 'duplex mismatch'. If one end of the link is fixed to full-duplex and the peer auto-negotiates, the auto-negotiating end falls back to half-duplex operation. At lower traffic volumes, the link may display few if any errors. As the traffic volume rises, the fixed negotiation side will begin to experience dropped packets while the auto-negotiating side will experience collisions. Ultimately, as traffic loads approach 100%, the link will become entirely unusable.

NOTE
The ping command with flood options is a useful tool for testing commissioned links. The command "ping 192.168.0.1 500 2" can be used to issue 500 pings each separated by two milliseconds to the next switch. If the link used is of high quality, then no pings should be lost and the average round trip time should be small.

Problem Two

I am trying to use the LFI protection feature but my links won't even come up.

Is it possible that the peer also has LFI enabled? If both sides of the link have LFI enabled, then both sides will withhold link signal generation from each other.

5 Ethernet Statistics

ROS Ethernet Statistics provide you with the following abilities:

- Viewing basic Ethernet statistics.
- Viewing and clearing detailed Ethernet statistics.
- Configuring RMON History control.
- Viewing collected RMON History samples.
- Configuring RMON Alarms.
- Configuring RMON Events.
- Viewing collected RMON Event logs.

The Ethernet Statistics menu is accessible from the main menu.

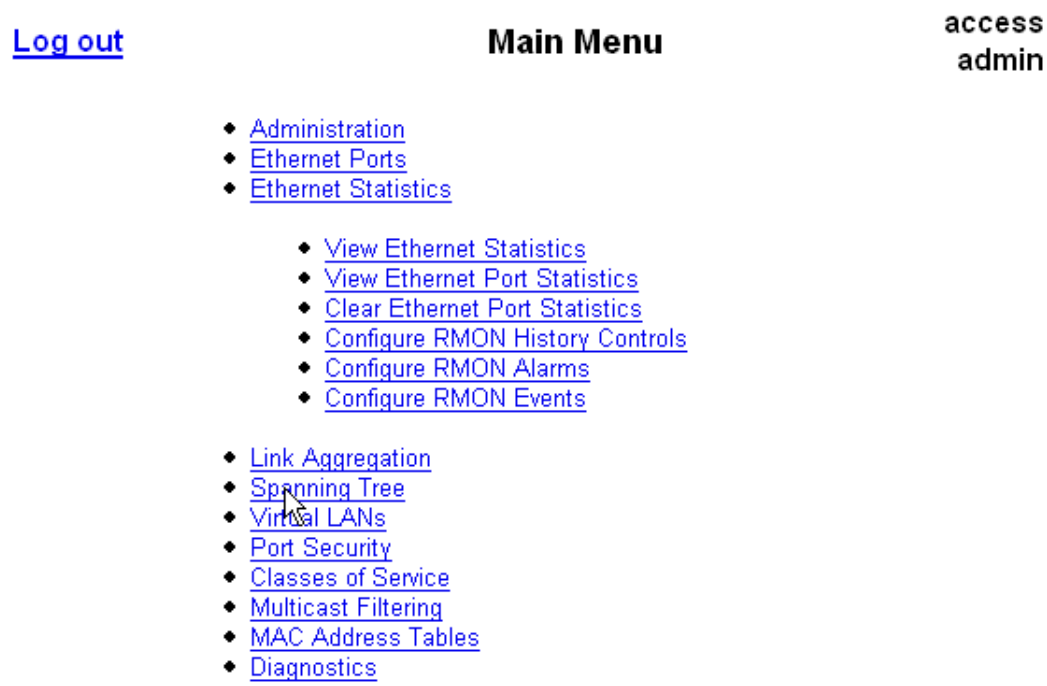
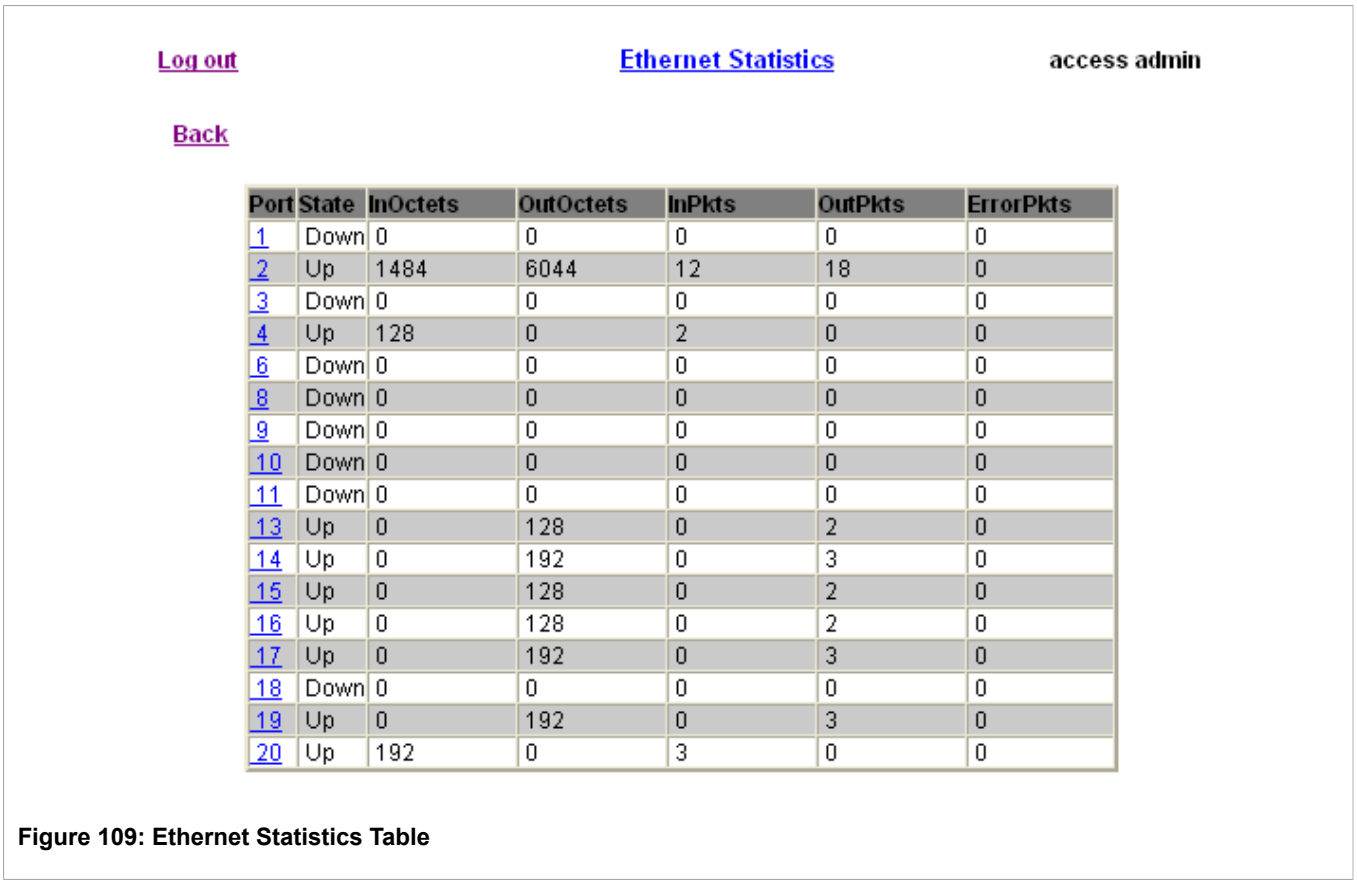


Figure 108: Ethernet Port Statistics Menu

Section 5.1

Viewing Ethernet Statistics

This table provides basic Ethernet statistics information which is reset periodically, every few seconds. This traffic view is useful when the origin and destination of a traffic flow need to be determined.



Port	State	InOctets	OutOctets	InPkts	OutPkts	ErrorPkts
1	Down	0	0	0	0	0
2	Up	1484	6044	12	18	0
3	Down	0	0	0	0	0
4	Up	128	0	2	0	0
6	Down	0	0	0	0	0
8	Down	0	0	0	0	0
9	Down	0	0	0	0	0
10	Down	0	0	0	0	0
11	Down	0	0	0	0	0
13	Up	0	128	0	2	0
14	Up	0	192	0	3	0
15	Up	0	128	0	2	0
16	Up	0	128	0	2	0
17	Up	0	192	0	3	0
18	Down	0	0	0	0	0
19	Up	0	192	0	3	0
20	Up	192	0	3	0	0

Figure 109: Ethernet Statistics Table

Parameter	Description
Port	**Synopsis:** 1 to maximum port number The port number as seen on the front plate silkscreen of the switch.
State	**Synopsis:** { ----, Down, Up } The port link status.
InOctets	**Synopsis:** 0 to 4294967295 The number of octets in received good packets (Unicast+Multicast+Broadcast) and dropped packets.
OutOctets	**Synopsis:** 0 to 4294967295 The number of octets in transmitted good packets.
InPkts	**Synopsis:** 0 to 4294967295 The number of received good packets (Unicast+Multicast+Broadcast) and dropped packets.
OutPkts	**Synopsis:** 0 to 4294967295 The number of transmitted good packets.
ErrorPkts	**Synopsis:** 0 to 4294967295 The number of any type of erroneous packet.

Section 5.2

Viewing Ethernet Port Statistics

Ethernet port statistics provide a detailed view of the traffic. This is useful when the exact source of error or traffic mix needs to be determined.

Log out

Ethernet Port Statistics

Back

Port	InOctets	OutOctets	InPkts	OutPkts	TotalInOctets	TotalInPkts	InBroadcasts	InMulticasts	CF
1	3673103	2640768	56235	33462	5716606	88166	2536	131	0
2	0	0	0	0	0	0	0	0	0
3	658288463	1287504977	1443028	5295204	658288463	1443028	11041	0	0
4	1353466121	690097031	5109227	1793529	1353634643	5110189	2586099	960891	0
5	2686153	273140867	21093	3624240	2686793	21103	20561	0	0
6	29330820	141833588	330643	895172	29336111	330722	200674	59062	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0

Figure 110: Ethernet Port Statistics Table

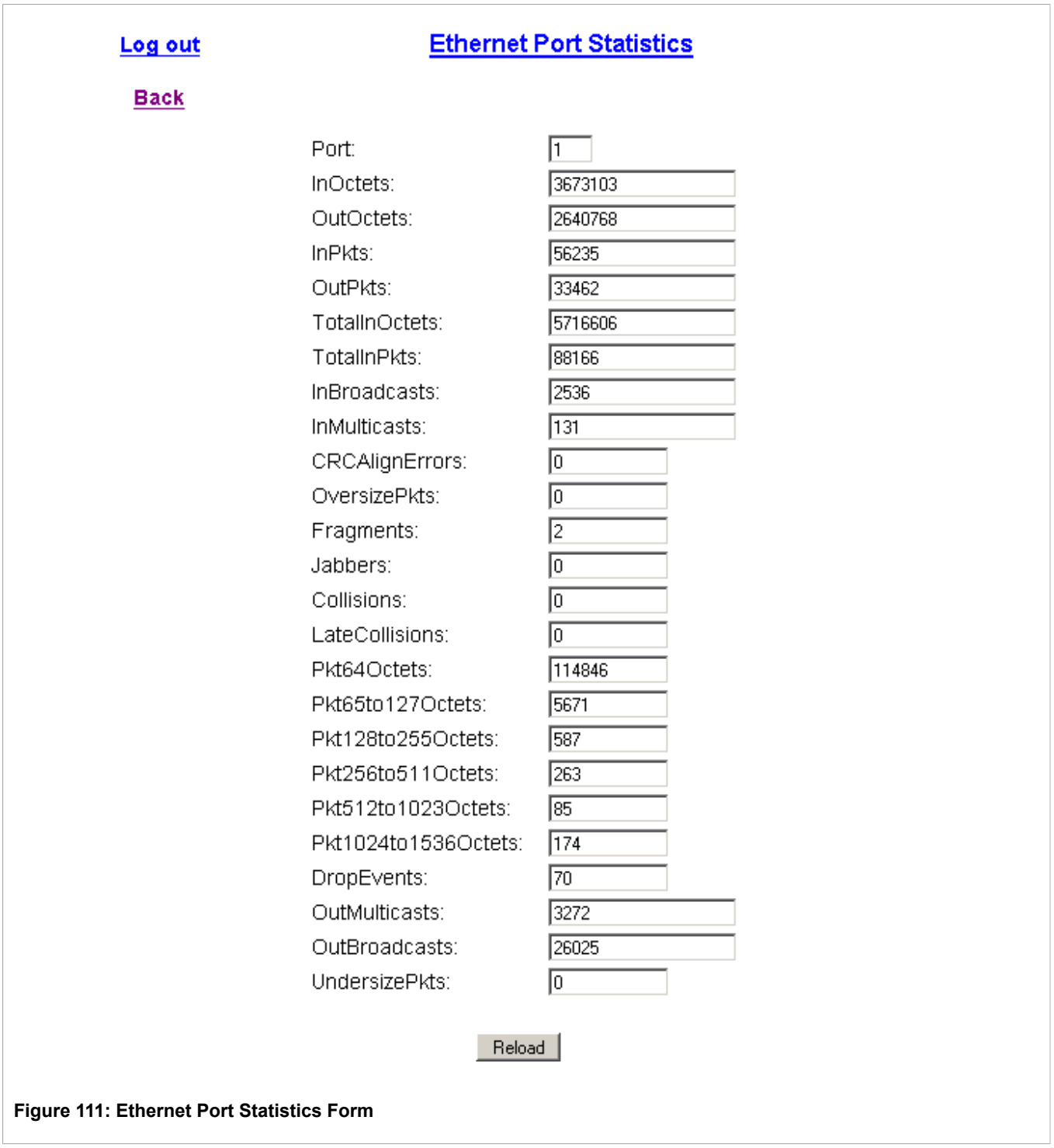


Figure 111: Ethernet Port Statistics Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number The port number as seen on the front plate silkscreen of the switch.
InOctets	**Synopsis:** 0 to 18446744073709551615

Parameter	Description
	The number of octets in both received packets (Unicast+Multicast+Broadcast) and dropped packets.
OutOctets	**Synopsis:** 0 to 18446744073709551615 The number of octets in transmitted packets.
InPkts	**Synopsis:** 0 to 18446744073709551615 The number of received good packets (Unicast+Multicast+Broadcast) and dropped packets.
OutPkts	**Synopsis:** 0 to 18446744073709551615 The number of transmitted good packets.
TotalInOctets	**Synopsis:** 0 to 18446744073709551615 The total number of octets of all received packets. This includes data octets of rejected and local packets which are not forwarded to the switching core for transmission. It should reflect all the data octets received on the line.
TotalInPkts	**Synopsis:** 0 to 18446744073709551615 The number of received packets. This includes rejected, dropped local, and packets which are not forwarded to the switching core for transmission. It should reflect all packets received on the line.
InBroadcasts	**Synopsis:** 0 to 18446744073709551615 The number of Broadcast packets received.
InMulticasts	**Synopsis:** 0 to 18446744073709551615 The number of Multicast packets received.
CRCAlignErrors	**Synopsis:** 0 to 4294967295 The number of packets received which meet all the following conditions: 1. Packet data length is between 64 and 1536 octets inclusive. 2. Packet has invalid CRC. 3. Collision Event has not been detected. 4. Late Collision Event has not been detected.
OversizePkts	**Synopsis:** 0 to 4294967295 The number of packets received with data length greater than 1536 octets and valid CRC.
Fragments	**Synopsis:** 0 to 4294967295 The number of packets received which meet all the following conditions: 1. Packet data length is less than 64 octets. 2. Collision Event has not been detected. 3. Late Collision Event has not been detected. 4. Packet has invalid CRC.
Jabbers	**Synopsis:** 0 to 4294967295 The number of packets which meet all the following conditions: 1. Packet data length is greater that 1536 octets. 2. Packet has invalid CRC.
Collisions	**Synopsis:** 0 to 4294967295 The number of received packets for which Collision Event has been detected.
LateCollisions	**Synopsis:** 0 to 4294967295 The number of received packets for which Late Collision Event has been detected.
Pkt64Octets	**Synopsis:** 0 to 4294967295

Parameter	Description
	The number of received and transmitted packets with size of 64 octets. This includes received and transmitted packets as well as dropped and local received packets. This does not include rejected received packets.
Pkt65to127Octets	**Synopsis:** 0 to 4294967295 The number of received and transmitted packets with a size of 65 to 127 octets. This includes received and transmitted packets as well as dropped and local received packets. This does not include rejected received packets.
Pkt128to255Octets	**Synopsis:** 0 to 4294967295 The number of received and transmitted packets with a size of 128 to 257 octets. This includes received and transmitted packets as well as dropped and local received packets. This does not include rejected received packets.
Pkt256to511Octets	**Synopsis:** 0 to 4294967295 The number of received and transmitted packets with a size of 256 to 511 octets. This includes received and transmitted packets as well as dropped and local received packets. This does not include rejected received packets.
Pkt512to1023Octets	**Synopsis:** 0 to 4294967295 The number of received and transmitted packets with a size of 512 to 1023 octets. This includes received and transmitted packets as well as dropped and local received packets. This does not include rejected received packets.
Pkt1024to1536Octets	**Synopsis:** 0 to 4294967295 The number of received and transmitted packets with a size of 1024 to 1536 octets. This includes received and transmitted packets as well as dropped and local received packets. This does not include rejected received packets.
DropEvents	**Synopsis:** 0 to 4294967295 The number of received packets that are dropped due to lack of receive buffers.
OutMulticasts	**Synopsis:** 0 to 18446744073709551615 The number of transmitted multicast packets. This does not include broadcast packets.
OutBroadcasts	**Synopsis:** 0 to 18446744073709551615 The number of transmitted broadcast packets.
UndersizePkts	**Synopsis:** 0 to 18446744073709551615 The number of received packets which meet all the following conditions: 1. Packet data length is less than 64 octets. 2. Collision Event has not been detected. 3. Late Collision Event has not been detected. 4. Packet has valid CRC.
OutUcastPkts	**Synopsis:** 0 to 18446744073709551615 The number of transmitted unicast packets.

Section 5.3
Clearing Ethernet Port Statistics

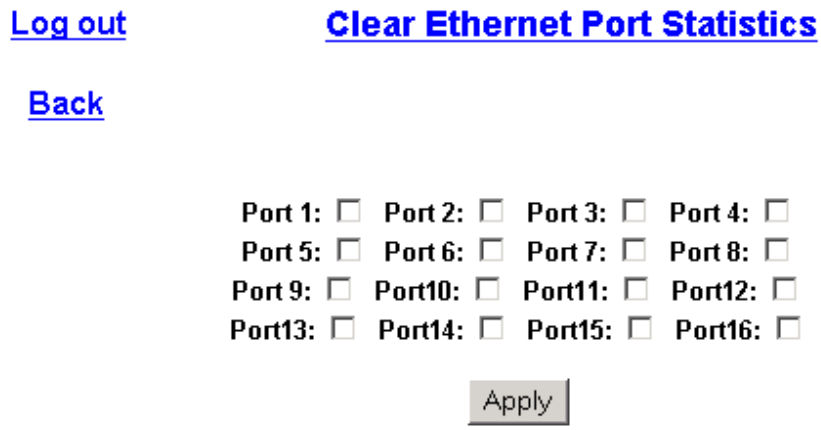


Figure 112: Clear Ethernet Port Statistics Form

This command clears Ethernet ports statistics for one or more Ethernet ports. Ports are chosen by checking the corresponding boxes.

Section 5.4
Remote Monitoring (RMON)

The Remote Monitoring (RMON) package provides the following capabilities:

- The ability to collect and view historical statistics in order to review performance and operation of Ethernet ports.
- The ability to record a log entry and/or generate an SNMP trap when the rate of occurrence of a specified event is exceeded.

Section 5.4.1
RMON History Controls

The RMON History Controls table programs the switch to take samples of the RMON-MIB history statistics of an Ethernet port at regular intervals.

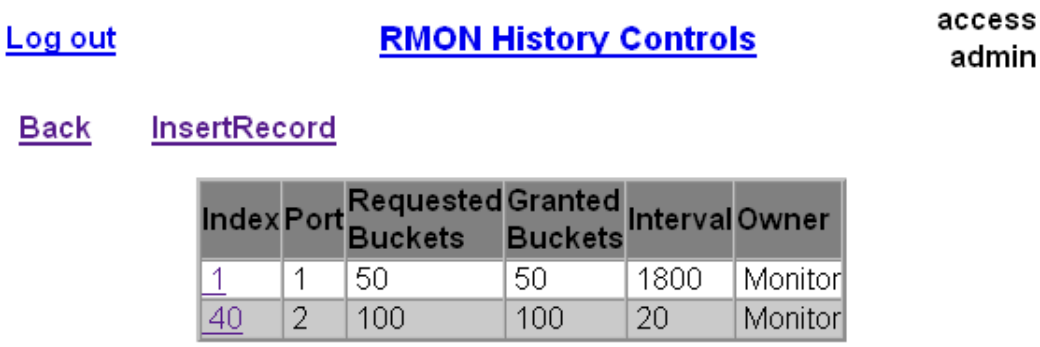


Figure 113: RMON History Controls Table

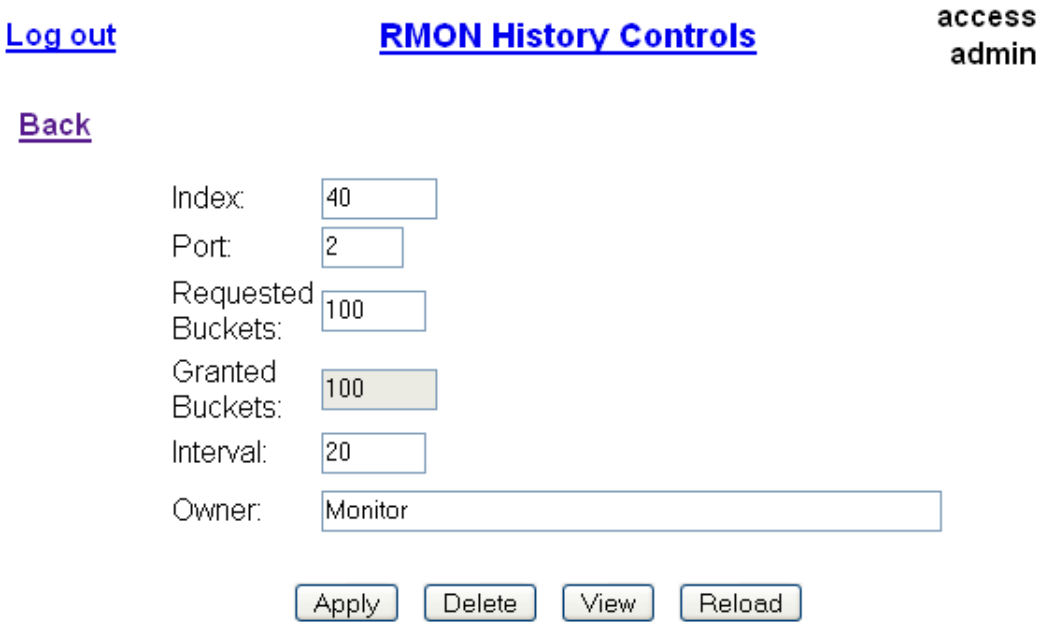


Figure 114: RMON History Controls Form

Parameter	Description
Index	**Synopsis:** 1 to 65535 **Default:** 1 The index of this RMON History Control record.
Port	**Synopsis:** 1 to maximum port number **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
Requested Buckets	**Synopsis:** 1 to 4000 **Default:** 50 The maximum number of buckets requested for this RMON collection history group of statistics. The range is 1 to 4000. The default is 50.

Parameter	Description
Granted Buckets	**Synopsis:** 0 to 65535 The number of buckets granted for this RMON collection history. This field is not editable.
Interval	**Synopsis:** 1 to 3600 **Default:** 1800 The number of seconds in over which the data is sampled for each bucket. The range is 1 to 3600. The default is 1800.
Owner	**Synopsis:** Any 127 characters **Default:** Monitor The owner of this record. It is suggested to start this string with the word 'monitor'.

Section 5.4.2

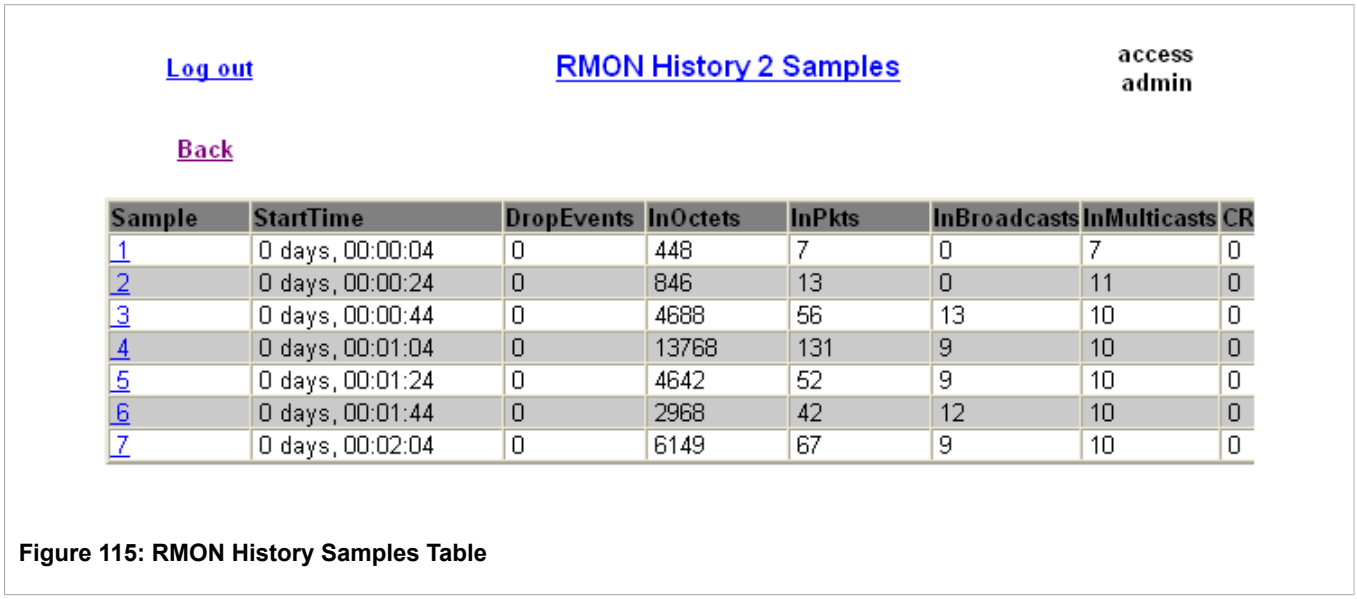
RMON History Samples

History samples for a particular record in the RMON History Control Table are displayed by selecting a particular record and view option. The index of the record will be included in the resulting menu title of the sample screen.

The table will present a series of samples. The sample number starts with one and increases by one with each new log entry. The oldest samples are deleted in favor of new samples when the allotted buckets are used.

The StartTime field provides the system time when the measurement interval started. The remaining fields provide the counts for each statistic as measured in the sample period.

Statistics collection begins whenever the History Control record is created and when the switch is initialized. As new samples are added, the window is automatically updated.



Sample	StartTime	DropEvents	InOctets	InPkts	InBroadcasts	InMulticasts	CR
1	0 days, 00:00:04	0	448	7	0	7	0
2	0 days, 00:00:24	0	846	13	0	11	0
3	0 days, 00:00:44	0	4688	56	13	10	0
4	0 days, 00:01:04	0	13768	131	9	10	0
5	0 days, 00:01:24	0	4642	52	9	10	0
6	0 days, 00:01:44	0	2968	42	12	10	0
7	0 days, 00:02:04	0	6149	67	9	10	0

Figure 115: RMON History Samples Table

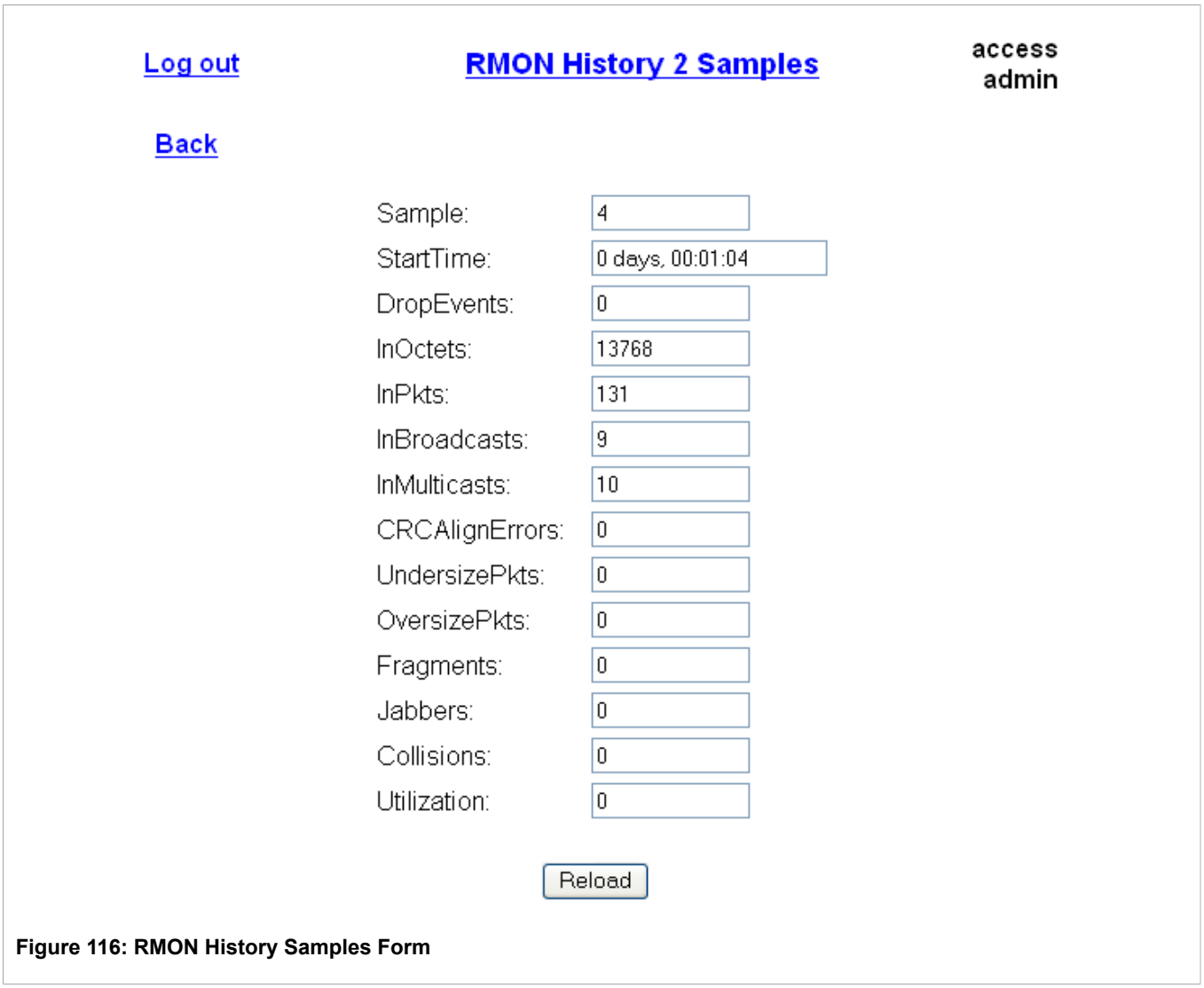


Figure 116: RMON History Samples Form

Parameter	Description
Sample	**Synopsis:** 0 to 4294967295 The sample number taken for this history record.
StartTime	**Synopsis:** DDDD days, HH:MM:SS The system elapsed time when started interval over which this sample was measured
DropEvents	**Synopsis:** 0 to 4294967295 The number of received packets that are dropped due to lack of receive buffers.
InOctets	**Synopsis:** 0 to 4294967295 The number of octets in good packets (Unicast+Multicast+Broadcast) and dropped packets received.
InPkts	**Synopsis:** 0 to 4294967295 The number of good packets (Unicast+Multicast+Broadcast) and dropped packets received.
InBroadcasts	**Synopsis:** 0 to 4294967295 The number of broadcast packets received.

Parameter	Description
InMulticasts	**Synopsis:** 0 to 4294967295 The number of multicast packets received.
CRCAlignErrors	**Synopsis:** 0 to 4294967295 The number of packets received that meet all the following conditions: 1. Packet data length is between 64 and 1536 octets inclusive. 2. Packet has invalid CRC. 3. Collision Event has not been detected. 4. Late Collision Event has not been detected.
UndersizePkts	**Synopsis:** 0 to 4294967295 The number of received packets that meet all the following conditions: 1. Packet data length is less than 64 octets. 2. Collision Event has not been detected. 3. Late Collision Event has not been detected. 4. Packet has valid CRC.
OversizePkts	**Synopsis:** 0 to 4294967295 The number of packets received with data length greater than 1536 octets and valid CRC.
Fragments	**Synopsis:** 0 to 4294967295 The number of packets received that meet all the following conditions: 1. Packet data length is less than 64 octets. 2. Collision Event has not been detected. 3. Late Collision Event has not been detected. 4. Packet has invalid CRC.
Jabbers	**Synopsis:** 0 to 4294967295 The number of packets that meet all the following conditions: 1. Packet data length is greater that 1536 octets. 2. Packet has invalid CRC.
Collisions	**Synopsis:** 0 to 4294967295 The number of received packets for which Collision Event has been detected.
Utilization	**Synopsis:** 0 to 100 The best estimate of the mean physical layer network utilization on this interface during this sampling interval (in percent).

Section 5.4.3
RMON Alarms

The RMON Alarm table configures the switch to examine the state of a specific statistical variable.

The record of this table contains an upper and a lower threshold for legal values of the statistic in a given interval. This provides the ability to detect events occurring more quickly than a specified maximum rate or less quickly than a specified minimum rate.

When a statistic value's rate of change exceeds its limits, an internal alarm of INFO level is always generated. Internal alarms can be viewed using the Diagnostics menu, View Alarms command.

Additionally, a statistic threshold crossing can result in further activity. The RMON Alarm record can be configured to point to a particular RMON Event Record, which can generate an SNMP trap, an entry in the switch's event log or both. The RMON Event Record can "steer" alarms towards different users defined in SNMP Users table.

The alarm record can point to a different event record for each of the thresholds, so combinations such as "trap on rising threshold" or "trap on rising threshold, log and trap on falling threshold" are possible.

Each RMON alarm may be configured such that its first instance occurs only for rising, falling, or all threshold excessions.

The ability to configure upper and lower thresholds on the value of a measured statistic provides for the ability to add hysteresis to the alarm generation process.

If the value of the measured statistic over time is compared to a single threshold, alarms will be generated each time the statistic crosses the threshold. If the statistic's value fluctuates around the threshold, an alarm can be generated every measurement period. Programming different upper and lower thresholds eliminates spurious alarms. The statistic value must "travel" between the thresholds before alarms can be generated.

The following figure illustrates the very different patterns of alarm generation resulting from a statistic sample and the same sample with hysteresis applied.

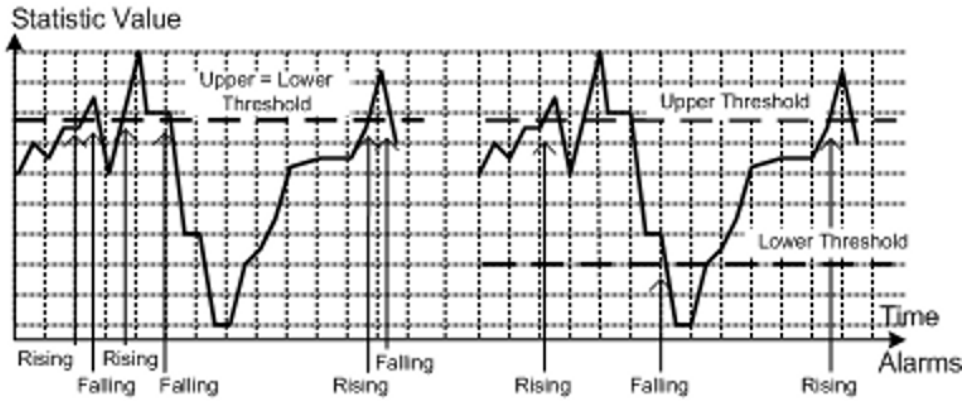


Figure 117: The Alarm Process

There are two methods to evaluate a statistic in order to determine when to generate an event; these are the delta and absolute methods.

For most statistics, such as line errors, it is appropriate to alarm when a rate is exceeded. The alarm record defaults to the "delta" measurement method, which examines changes in a statistic at the end of each measurement period.

It may be desirable to alarm when the total, or absolute, number of events crosses a threshold. In this case, set the measurement period type to "absolute".

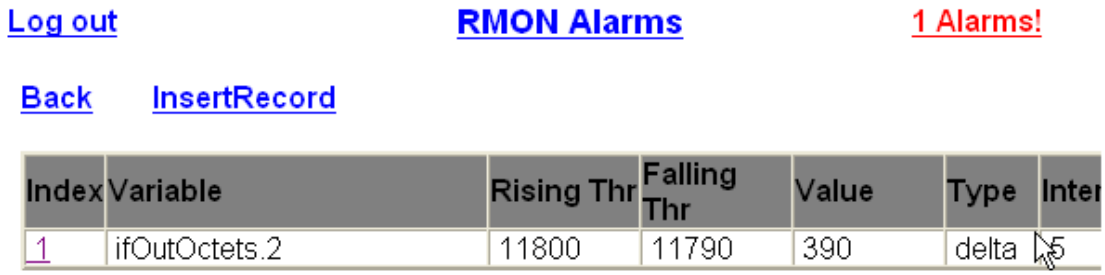


Figure 118: RMON Alarms Table

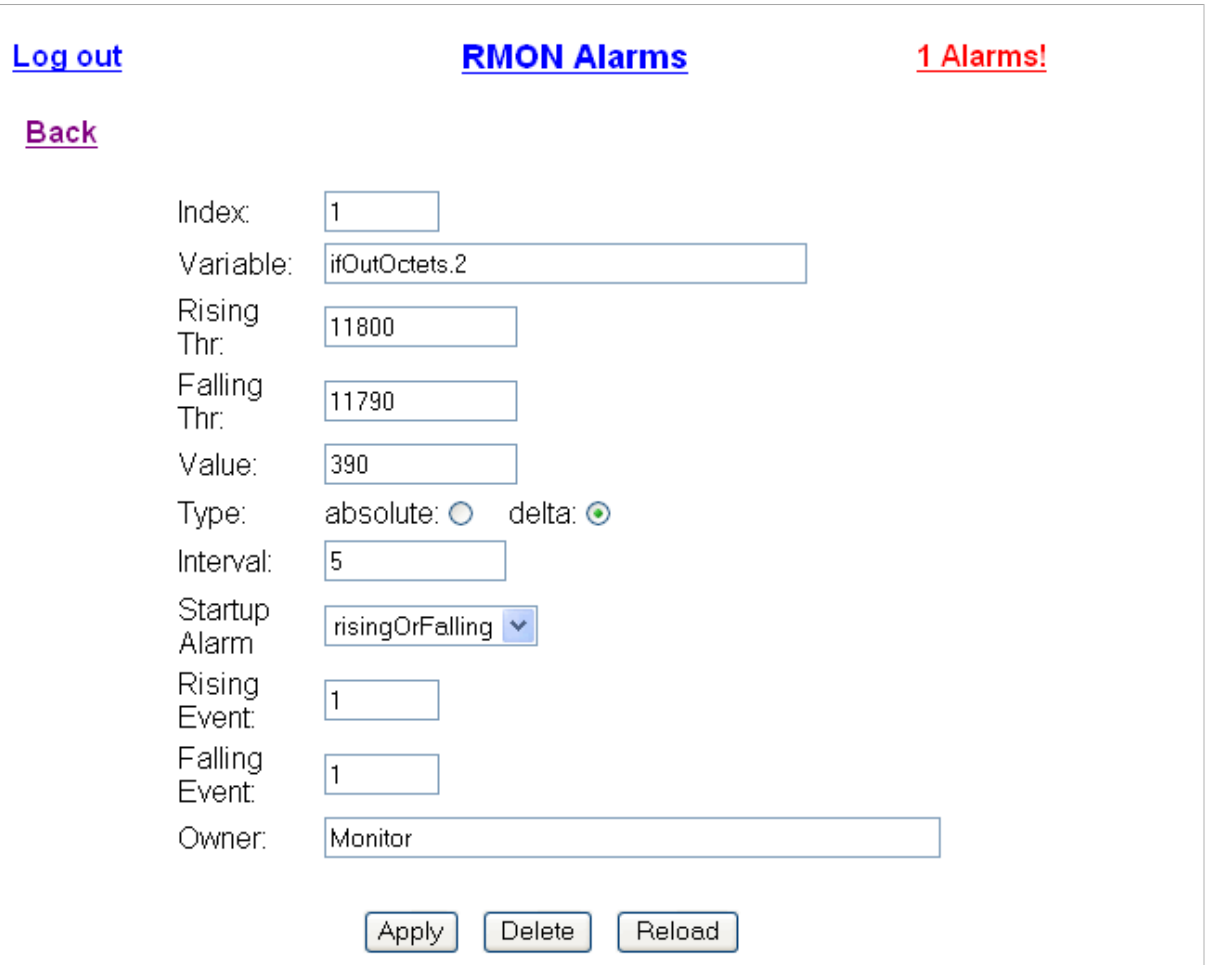


Figure 119: RMON Alarms Form

Parameter	Description
Index	**Synopsis:** 1 to 65535 **Default:** 2 The index of this RMON Alarm record.
Variable	**Synopsis:** SNMP Object Identifier - up to 39 characters **Default:** ifOutOctets.2

Parameter	Description
	The SNMP object identifier (OID) of the particular variable to be sampled. Only variables that resolve to an ASN.1 primitive type INTEGER (INTEGER, Integer32,Counter32, Counter64, Gauge, or TimeTicks) may be sampled. A list of objects can be printed using shell command 'rmon'. The OID format: objectName.index1.index2… where index format depends on index object type.
Rising Threshold	**Synopsis:** 0 to 2147483647 **Default:** 11800 A threshold for the sampled variable. When the current sampled variable value is greater than or equal to this threshold, and the value at the last sampling interval was less than this threshold, a single event will be generated. A single event will also be generated if the first sample created after this record is greater than or equal to this threshold and the associated startup alarm is equal to 'rising'. After a rising alarm is generated, another such event will not be generated until the sampled value falls below this threshold and reaches the value of FallingThreshold.
Falling Threshold	**Synopsis:** 0 to 2147483647 **Default:** 11790 A threshold for the sampled variable. When the current sampled variable value is less than or equal to this threshold, and the value at the last sampling interval was greater than this threshold, a single event will be generated. A single event will also be generated if the first sample created after this record is less than or equal to this threshold and the associated startup alarm is equal to 'falling'. After a falling alarm is generated, another such event will not be generated until the sampled value rises above this threshold and reaches the value of RisingThreshold.
Value	**Synopsis:** 0 to 2147483647 The value of a monitored object during the last sampling period. The presentation of the value depends on the sample type ('absolute' or 'delta').
Type	**Synopsis:** { absolute, delta } **Default:** delta The method of sampling the selected variable and calculating the value to be compared against the thresholds. The value of the sample type can be 'absolute' or 'delta'.
Interval	**Synopsis:** 0 to 2147483647 **Default:** 5 The number of seconds during which the data is sampled and compared with the rising and falling thresholds.
Startup Alarm	**Synopsis:** { rising, falling, risingOrFalling } **Default:** risingOrFalling The alarm that may be sent when this record is first created if the condition for raising an alarm is met. The value of a startup alarm can be 'rising', 'falling' or 'risingOrFalling'
Rising Event	**Synopsis:** 0 to 65535 **Default:** 1 The index of the event that is used when a falling threshold is crossed. If there is no corresponding entry in the Event Table, then no association exists. In particular, if this value is zero, no associated event will be generated.
Falling Event	**Synopsis:** 0 to 65535 **Default:** 1 The index of the event that is used when a rising threshold is crossed. If there is no corresponding entry in the Event Table, then no association exists. In particular, if this value is zero, no associated event will be generated.
Owner	**Synopsis:** Any 127 characters **Default:** Monitor The owner of this record. It is suggested to start this string with the word 'monitor'.

Section 5.5

RMON Events

The RMON Events Table stores profiles of behavior used in event logging. These profiles are used by RMON Alarm records to send traps and to log events.

Each record may specify that an alarms log entry be created on its behalf whenever the event occurs. Each entry may also specify that a notification should occur by way of SNMP trap messages. In this case, the user for the trap message is given as parameter “Community”.

Two traps are defined: risingAlarm and fallingAlarm.

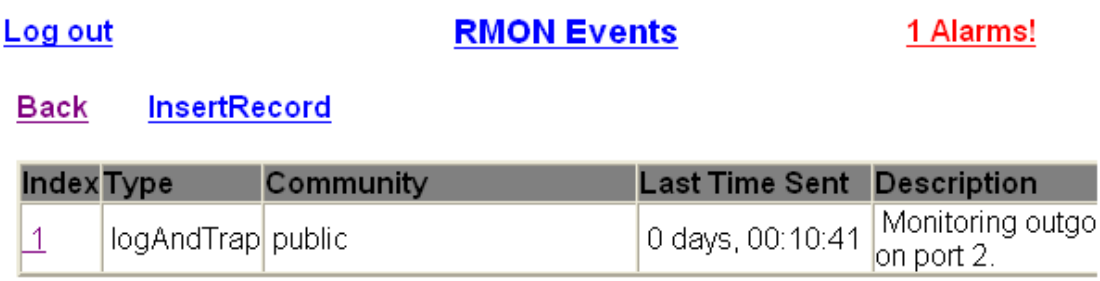


Figure 120: RMON Events Table

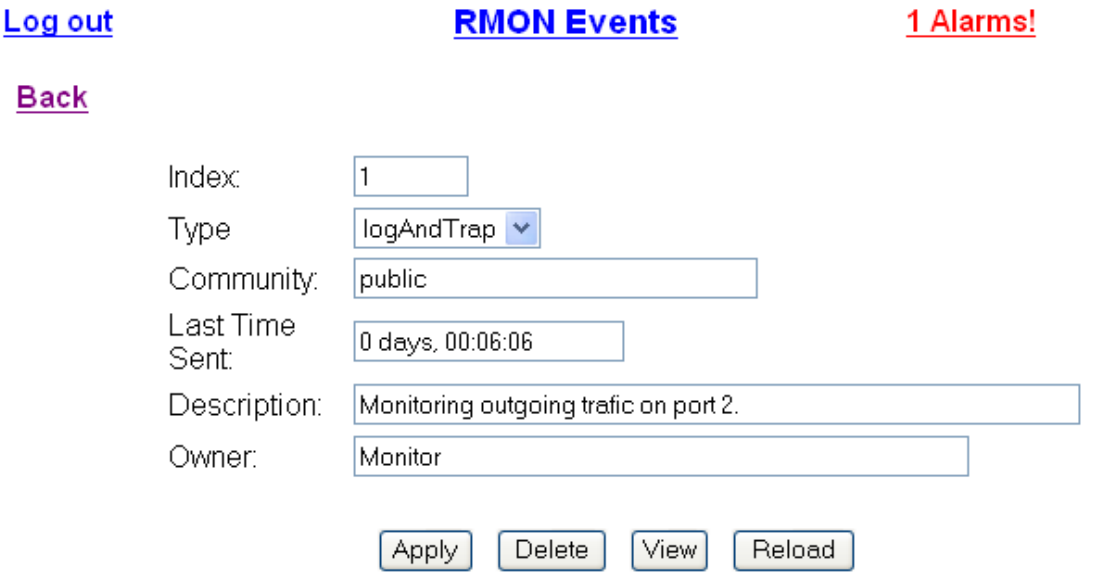


Figure 121: RMON Events Form

Parameter	Description
Index	**Synopsis:** 1 to 65535 **Default:** 2 The index of this RMON Event record.

Parameter	Description
Type	**Synopsis:** { none, log, snmpTrap, logAndTrap } **Default:** logAndTrap The type of notification that the probe will make about this event. In the case of 'log', an entry is made in the RMON Log table for each event. In the case of snmp_trap, an SNMP trap is sent to one or more management stations.
Community	**Synopsis:** Any 31 characters **Default:** public If the SNMP trap is to be sent, it will be sent to the SNMP community specified by this string.
Last Time Sent	**Synopsis:** DDDD days, HH:MM:SS The time from last reboot at the time this event entry last generated an event. If this entry has not generated any events, this value will be 0.
Description	**Synopsis:** Any 127 characters **Default:** Monitoring outgoing traffic on port 2. A comment describing this event.
Owner	**Synopsis:** Any 127 characters **Default:** Monitor The owner of this event record. It is suggested to start this string with the word 'monitor'.

Section 5.6
RMON Event Log

Event logs for a particular record in the RMON Events Table can be viewed by selecting a particular record and view option. The index of the record will be included in the resulting menu title of the log table.

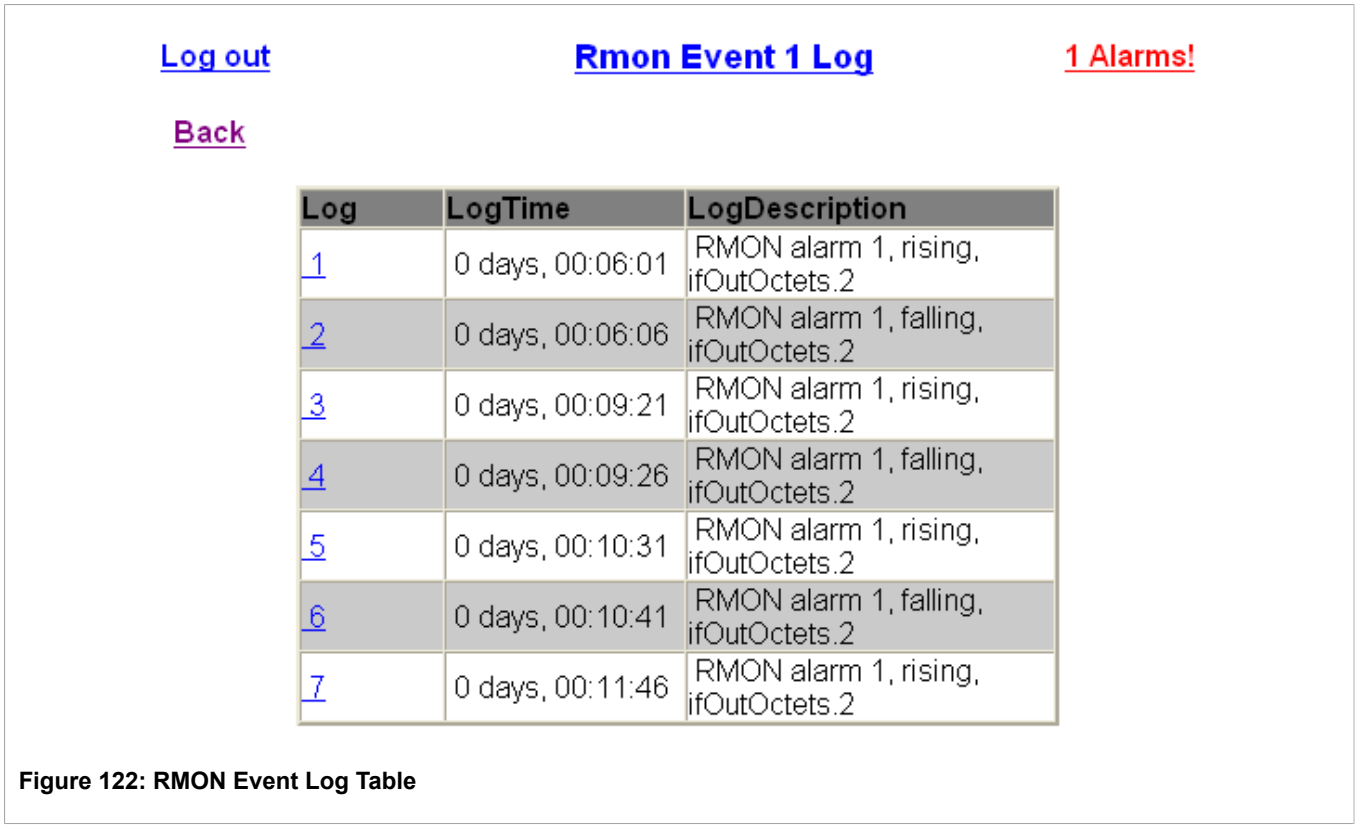


Figure 122: RMON Event Log Table

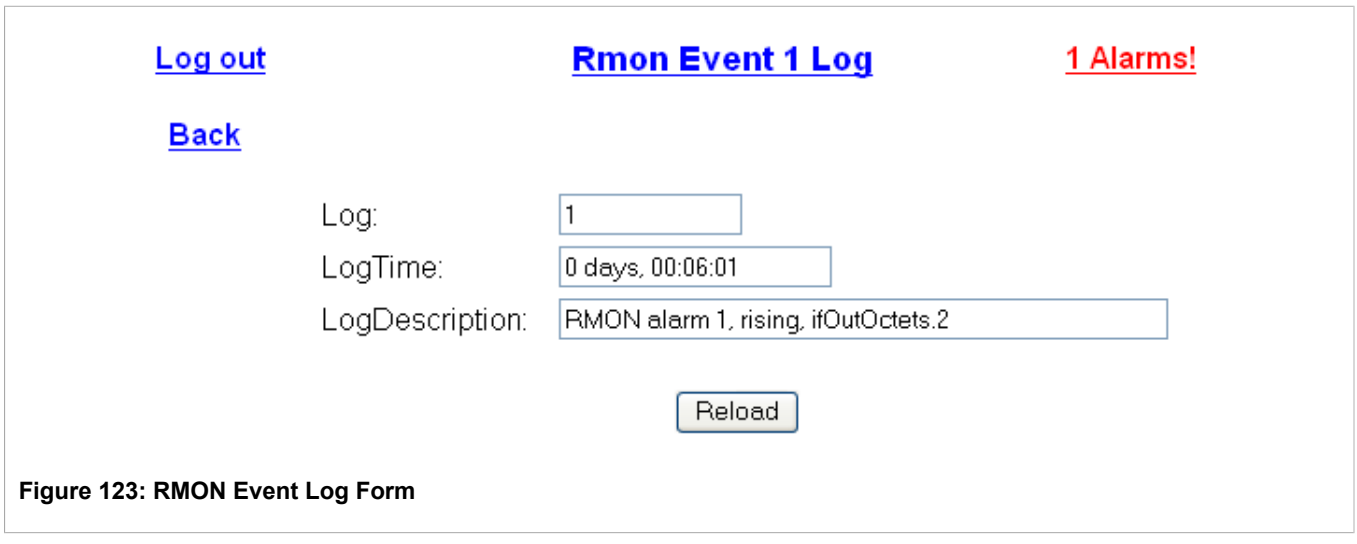


Figure 123: RMON Event Log Form

Parameter	Description
Log	**Synopsis:** 0 to 4294967295 The index (log) taken for this log record.
LogTime	**Synopsis:** DDDD days, HH:MM:SS The system elapsed time when this log was created.
LogDescription	**Synopsis:** Any 49 characters The description of the event that activated this log entry.

Section 5.7

List of Objects Eligible for RMON Alarms

The following table lists ROS database objects which are eligible for RMON alarms:

dot1dBasePortMtuExceededDiscards	The number of frames discarded by this port due to an excessive size.
dot1dTpPortInFrames	The number of frames that have been received by this port from its segment.
dot1dTpPortOutFrames	The number of frames that have been transmitted by this port to its segment.
dot1qVlanNumDeletes	The number of times a VLAN entry has been deleted from the dot1qVlanCurrentTable (for any reason). If an entry is deleted, then inserted, and then deleted, this counter will be incremented by 2.
etherStatsBroadcastPkts	The number of good Broadcast packets received.
etherStatsCollisions	The best estimate of the total number of collisions on this Ethernet segment.
etherStatsCRCAlignErrors	The number of packets received which meet all the following conditions:1. Packet data length is between 64 and 1536 bytes inclusive.2. Packet has invalid CRC.3. Collision Event has not been detected.4. Late Collision Event has not been detected.
etherStatsDropEvents	The number of received packets that are dropped due to lack of receive buffers.
etherStatsFragments	The number of packets received which meet all the following conditions:1. Packet data length is less than 642. Collision Event has not been detected.3. Late Collision Event has not been detected.4. CRC invalid.
etherStatsJabbers	The total number of packets received that were longer than 1518 bytes and had either a bad Frame Check Sequence or Alignment Error.
etherStatsMulticastPkts	The number of good Multicast packets received.
etherStatsOctets	The number of bytes in received good packets (Unicast+Multicast+Broadcast) and dropped packets.
etherStatsOversizePkts	The number of packets received with data length greater than 1536 bytes and valid CRC.
etherStatsPkts	The number of received good packets (Unicast+Multicast+Broadcast) and dropped packets
etherStatsPkts1024to1518Octets	The total number of received packets that were between 1024 and 1518 bytes long.
etherStatsPkts128to255Octets	The total number of received packets that were between 128 and 255 bytes long.
etherStatsPkts256to511Octets	The total number of received packets that were between 256 and 511 bytes long.
etherStatsPkts512to1023Octets	The total number of received packets that were between 512 and 1023 bytes long.
etherStatsPkts64Octets	The total number of received packets that were 64 bytes long.
etherStatsPkts65to127Octets	The total number of received packets that were between 65 and 127 bytes long.
etherStatsUndersizePkts	The number of received packets which meet all the following conditions:1. Packet data length is less than 64 bytes.2. Collision Event has not been detected.3. Late Collision Event has not been detected.4. Packet has valid CRC.
ifHCInBroadcastPkts	The total number of good packets received that were directed to the broadcast address. This object is a 64 bit version of ifInBroadcastPkts.
ifHCInMulticastPkts	The total number of good packets received that were directed to multicast address.

ifHCInOctets	The total number of bytes received on the interface, including framing characters. This object is a 64 bit version of ifInOctets.
ifHCInUcastPkts	The number of packets, delivered by this sub-layer to a higher (sub-)layer, which, were not addressed to a multicast or broadcast address at this sub-layer. This object is a 64 bit version of ifInUcastPkts.
ifHCOutBroadcastPkts	The total number of packets transmitted that were directed to the broadcast address. This object is a 64 bit version of ifOutBroadcastPkts.
ifHCOutMulticastPkts	The total number of packets transmitted that were directed to multicast address. This object is a 64 bit version of ifOutMulticastPkts.
ifHCOutOctets	The total number of bytes transmitted out of the interface. This object is a 64 bit version of ifOutOctets.
ifInBroadcastPkts	The total number of good packets received that were directed to the broadcast address.
ifInDiscards	The number of received packets that are dropped due to lack of receive buffers.
ifInErrors	The number of received packets that contained errors preventing them from being deliverable to a higher-layer protocol.
ifInMulticastPkts	The total number of good packets received that were directed to multicast address.
ifInNUcastPkts	The number of packets, delivered by this sub-layer to a higher (sub-)layer, which, were addressed to a multicast or broadcast address at this sub-layer.
ifInOctets	The total number of bytes received on the interface, including framing characters.
ifInUcastPkts	The number of packets, delivered by this sub-layer to a higher (sub-)layer, which, were not addressed to a multicast or broadcast address at this sub-layer.
ifOutBroadcastPkts	The total number of packets transmitted that were directed to the broadcast address.
ifOutMulticastPkts	The total number of packets transmitted that were directed to multicast address.
ifOutNUcastPkts	The total number of transmitted packets which were addressed to a multicast or broadcast address.
ifOutOctets	The total number of bytes transmitted out of the interface.
ifOutUcastPkts	The total number of transmitted packets which were not addressed to a multicast or broadcast address. This object is a 64 bit version of ifOutUcastPkts.
ifOutUcastPkts	The total number of transmitted packets which were not addressed to a multicast or broadcast address.
ipForwDatagrams	The number of input datagrams for which this entity was not their final IP destination, as a result of which an attempt was made to find a route to forward them to that final destination. In entities which do not act as IP routers, this counter will include only those packets which were Source-Routed via this entity, and the Source-route option processing was successful.
ipFragCreates	The number of IP datagram fragments that have been generated as a result of fragmentation at this entity.
ipFragFails	The number of IP datagrams that have been discarded because they needed to be fragmented at this entity but could not be, e.g., because their Don't Fragment flag was set.
ipFragOKs	The number of IP datagrams that have been successfully fragmented at this entity.
ipInAddrErrors	The number of input datagrams discarded because the IP address in their header's destination field was not a valid address to be received at this entity. This count includes invalid addresses and addresses of unsupported Classes. For entities which are not IP routers and therefore do not forward datagrams, this

	counter includes datagrams discarded because the destination address was not a local address.
ipInDelivers	The total number of input datagrams successfully delivered to IP user-protocols (including ICMP)
ipInDiscards	The number of input IP datagrams for which no problems were encountered to prevent their continued processing, but which were discarded (e.g., for lack of buffer space). Note that this counter does not include any datagrams discarded while awaiting reassembly
ipInHdrErrors	The number of input datagrams discarded due to errors in their IP headers, including bad checksums, version number mismatch, other format errors, time-to-live exceeded, errors discovered in processing their IP options, etc.
ipInReceives	The total number of input datagrams received from interfaces, including those received in error.
ipInUnknownProtos	The number of locally addressed datagrams received successfully but discarded because of an unknown or unsupported protocol.
ipOutDiscards	The number of output IP datagrams for which no problem was encountered to prevent their transmission to their destination, but which were discarded (e.g., for lack of buffer space). Note that this counter would include datagrams counted in ipForwDatagrams if any such packets met this (discretionary) discard criterion.
ipOutNoRoutes	The number of IP datagrams discarded because no route could be found to transmit them to their destination. Note that this counter includes any packets counted in ipForwDatagrams which meet this `no-route' criterion. Note that this includes any datagrams which a host cannot route because all of its default routers are down.
ipOutRequests	The total number of IP datagrams which local IP user-protocols (including ICMP) supplied to IP in requests for transmission. Note that this counter does not include any datagrams counted in ipForwDatagrams.
ipRasmReqds	The number of IP fragments received which needed to be reassembled at this entity.
ipReasmFails	The number of IP datagrams successfully reassembled.
lldpStatsRemTablesAgeouts	The number of times the complete set of information has been deleted from tables contained in lldpRemoteSystemsData objects because the information timeliness interval has expired.
lldpStatsRemTablesDeletes	The number of times the complete set of information has been deleted from tables contained in lldpRemoteSystemsData objects.
lldpStatsRemTablesDrops	The number of times the complete set of information could not be entered into tables contained in lldpRemoteSystemsData objects because of insufficient resources.
lldpStatsRemTablesInserts	The number of times the complete set of information has been inserted into tables contained in lldpRemoteSystemsData.
lldpStatsRxPortAgeoutsTotal	The counter that represents the number of age-outs that occurred on a given port. An age-out is the number of times the complete set of information advertised by a neighbour has been deleted from tables contained in lldpRemoteSystemsData objects because the information timeliness interval has expired.
lldpStatsRxPortFramesDiscardedTotal	The number of LLDP frames received by this LLDP agent on the indicated port and then discarded for any reason. This counter can provide an indication that LLDP header formatting problems may exist with the local LLDP agent in the sending system or that LLDPDU validation problems may exist with the local LLDP agent in the receiving system.
lldpStatsRxPortFramesErrors	The number of invalid LLDP frames received by this LLDP agent on the indicated port, while this LLDP agent is enabled.

lldpStatsRxPortFramesTotal	The number of valid LLDP frames received by this LLDP agent on the indicated port, while this LLDP agent is enabled.
lldpStatsRxPortTLVsDiscardedTotal	The number of LLDP TLVs discarded for any reason by this LLDP agent on the indicated port.
lldpStatsRxPortTLVsUnrecognizedTotal	The number of LLDP TLVs received on the given port that are not recognized by this LLDP agent on the indicated port.
rcDeviceStsTemperature	The temperature measured in the device.
rs232AsyncPortFramingErrs	The total number of characters with a framing error, input from the port since system re-initialization.
rs232AsyncPortOverrunErrs	The total number of characters with an overrun error, input from the port since system re-initialization.
rs232AsyncPortParityErrs	The total number of characters with a parity error, input from the port since system re-initialization.
snmpInASNParseErrs	The total number of ASN.1 or BER errors encountered by the SNMP Agent decoding received SNMP messages.
snmpInBadCommunityNames	The total number of SNMP messages delivered to the SNMP Agent which represented an SNMP operation which was not allowed by the SNMP community named in the message.
snmpInBadCommunityNames	The total number of SNMP messages delivered to the SNMP Agent which used a unknown SNMP community name.
snmpInBadVersions	The total number of SNMP messages which were delivered to the SNMP Agent and were for an unsupported SNMP version.
snmpInPkts	The number of messages delivered to the SNMP Agent.
tcpActiveOpens	The number of times TCP connections have made a direct transition to the SYN-SENT state from the CLOSED state.
tcpAttemptFails	The number of times TCP connections have made a direct transition to the CLOSED state from either the SYN-SENT or the SYN-RCVD, plus the number of times TCP connections have made a direct transition to the LISTEN state from the SYN-RCVD.
tcpCurrEstab	The number of TCP connections for which the current state is either ESTABLISHED or CLOSE- WAIT.
tcpEstabResets	The number of times TCP connections have made a direct transition to the CLOSED state from either the ESTABLISHED state or the CLOSE-WAIT state
tcpInSegs	The total number of segments received, including those received in error.
tcpOutSegs	The total number of segments sent, including those on current connections but excluding those containing only retransmitted bytes.
tcpPassiveOpens	The number of times TCP connections have made a direct transition to the SYN-RCVD state from the LISTEN state.
tcpRetransSegsDescr	The total number of segments retransmitted - that is, the number of TCP segments transmitted containing one or more previously transmitted bytes.
udpInDatagrams	The total number of UDP datagrams received and delivered to UDP users.
udpInErrors	The number of received UDP datagrams that could not be delivered for reasons other than the lack of an application at the destination port.
udpNoPorts	The total number of received UDP datagrams for which there was no application at the destination port.
udpOutDatagrams	The number of sent UDP datagrams.

6 Link Aggregation

Link Aggregation is also known as port trunking or port bundling.

ROS provides the following Link Aggregation features:

- Support for up to 15 port trunks.

  NOTE
  The actual maximum number of port trunks depends on the number of ports in the switch (at least two ports are required to compose a port trunk)

- Up to 8 ports can be aggregated in one port trunk.
- Highly randomized load balancing between the aggregated links based on both source and destination MAC addresses of the forwarded frames.

Section 6.1

Link Aggregation Operation

Link Aggregation provides you with the ability to aggregate several Ethernet ports into one logical link (port trunk) with higher bandwidth. Link Aggregation can be used for two purposes:

- To obtain increased, linearly incremental, link bandwidth.
- To improve network reliability by creating link redundancy. If one of the aggregated links fails, the switch will balance the traffic between the remaining links.

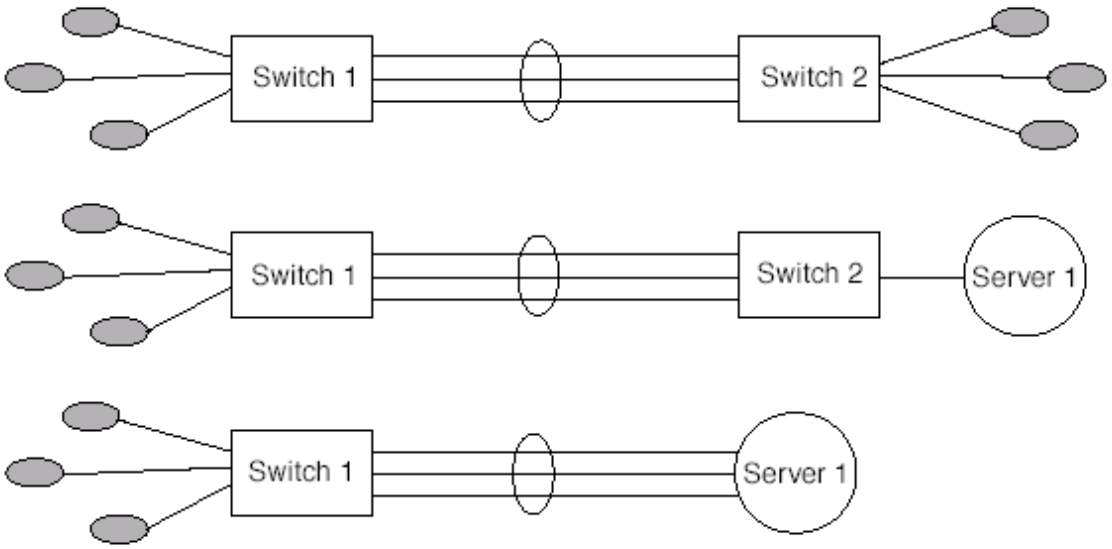


Figure 124: Link Aggregation Examples

Section 6.1.1

Link Aggregation Rules

- Any port can belong to only one port trunk at a time.
- The aggregated port with the lowest port number is called the Port Trunk Primary Port. Other ports in the trunk are called Secondary Ports.
- Layer 2 features (e.g. STP, VLAN, CoS, Multicast Filtering) treat a port trunk as a single link.
  - If STP puts an aggregated port in blocking/forwarding, it does it for the whole port trunk
  - If one of the aggregated ports joins/leaves a multicast group (e.g. via IGMP or GMRP), all other ports in the trunk will join/leave too.
  - Any port configuration parameter (e.g. VLAN, CoS) change will be automatically applied to all ports in the trunk.
  - Configuration/status parameters of the secondary ports will not be shown and their port numbers will be simply listed next to the primary port number in the appropriate configuration/status UI sessions. For example:

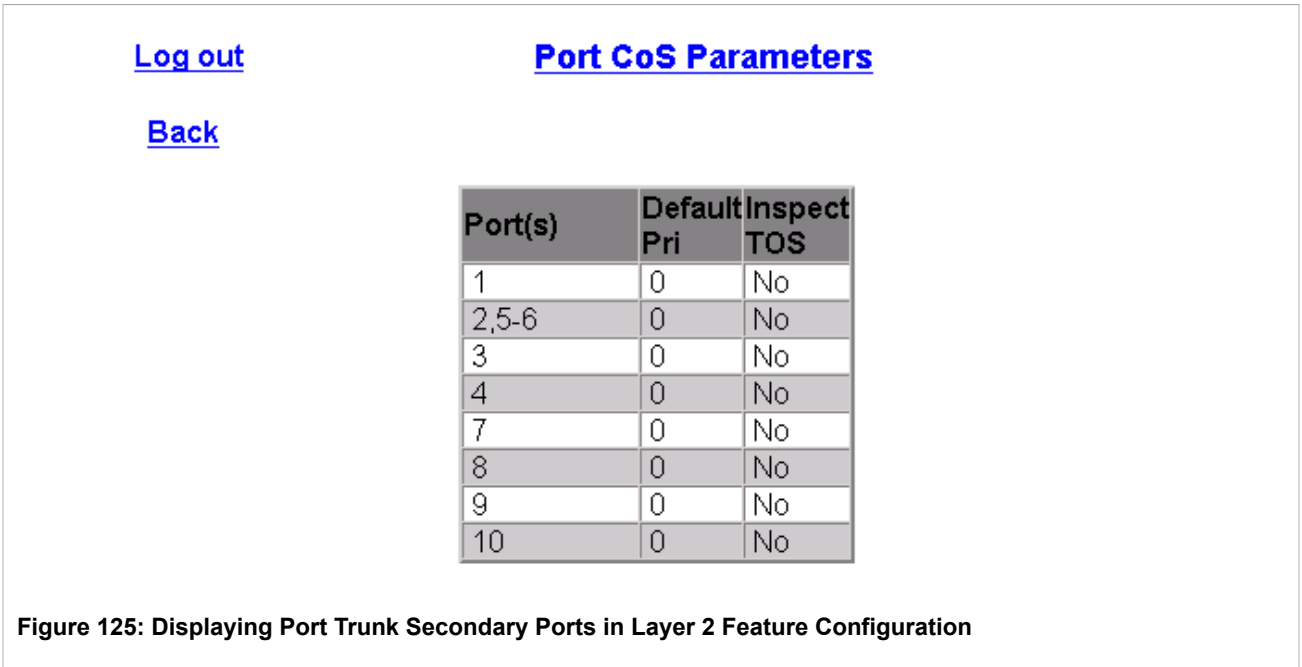


Figure 125: Displaying Port Trunk Secondary Ports in Layer 2 Feature Configuration

  - When a secondary port is added to a port trunk, it inherits all the configuration settings of the primary port. When this secondary port is removed from the port trunk, the settings it had previous to the aggregation are restored.
- Physical layer features (e.g. physical link configuration, link status, rate limiting, Ethernet statistics) will still treat each aggregated port separately.
  - Physical configuration/status parameters will NOT be automatically applied to other ports in the trunk and will be displayed for each port as usual.
  - Make sure that only ports with the same speed and duplex settings are aggregated. If auto-negotiation is used, make sure it is resolved to the same speed for all ports in the port trunk.
  - To get a value of an Ethernet statistics counter for the port trunk, add the values of the counter of all ports in the port trunk.

Section 6.1.2
Link Aggregation Limitations

- A port mirroring target port can not be member of a port trunk. However, a port mirroring source port can be member of a port trunk.
- A port working in QinQ mode cannot be a member of a port trunk.
- DHCP Relay Agent Client port cannot be a member of a port trunk.
- Load balancing between the links of a bundle is randomized and may not be ideal. For instance, if three 100Mbs links are aggregated, the resulting bandwidth of the port trunk may not be precisely 300Mbs.
- A Static MAC Address should not be configured to reside on an aggregated port – it may cause some frames destined for that address to be dropped.
- A secure port cannot be a member of a port trunk.

NOTE
The port trunk must be properly configured on both sides of the aggregated link. In switch-to-switch connections, if the configuration of both sides does not match (i.e. some ports are mistakenly not included in the port trunk), it will result in a loop. So the following procedure is strongly recommended to configure a port trunk.

a. *Disconnect or disable all the ports involved in the configuration, i.e. either being added to or removed from the port trunk.*
b. *Configure the port trunk on both switches.*
c. *Double-check the port trunk configuration on both switches.*
d. *Reconnect or re-enable the ports.*

If the port trunk is being configured while the ports are not disconnected or disabled, the port will be disabled for a few seconds automatically.

NOTE
The IEEE 802.3ad Link Aggregation standard requires all physical links in the port trunk to run at the same speed and in full-duplex mode. If this requirement is violated, the performance of the port trunk will drop.

The switch will raise an appropriate alarm, if such a speed/duplex mismatch is detected.

NOTE
STP dynamically calculates the path cost of the port trunk based on its aggregated bandwidth. However, if the aggregated ports are running at different speeds, the path cost may not be calculated correctly.

NOTE
Enabling STP is the best way for handling link redundancy in switch-to-switch connections composed of more than one physical link. If STP is enabled and increased bandwidth is not required, Link Aggregation should not be used because it may lead to a longer fail-over time.

Section 6.2
Link Aggregation Configuration

The Link Aggregation menu is accessible from the main menu.

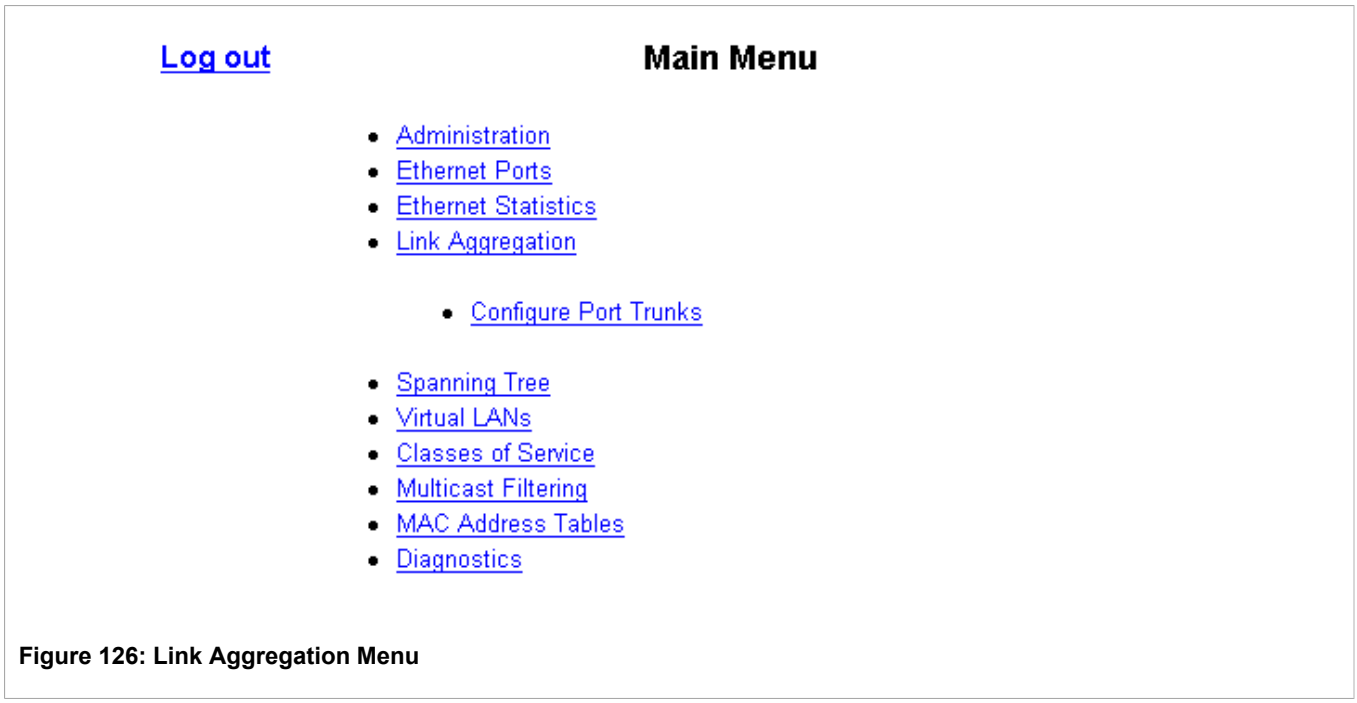


Figure 126: Link Aggregation Menu

Section 6.2.1

Configuring Port Trunks

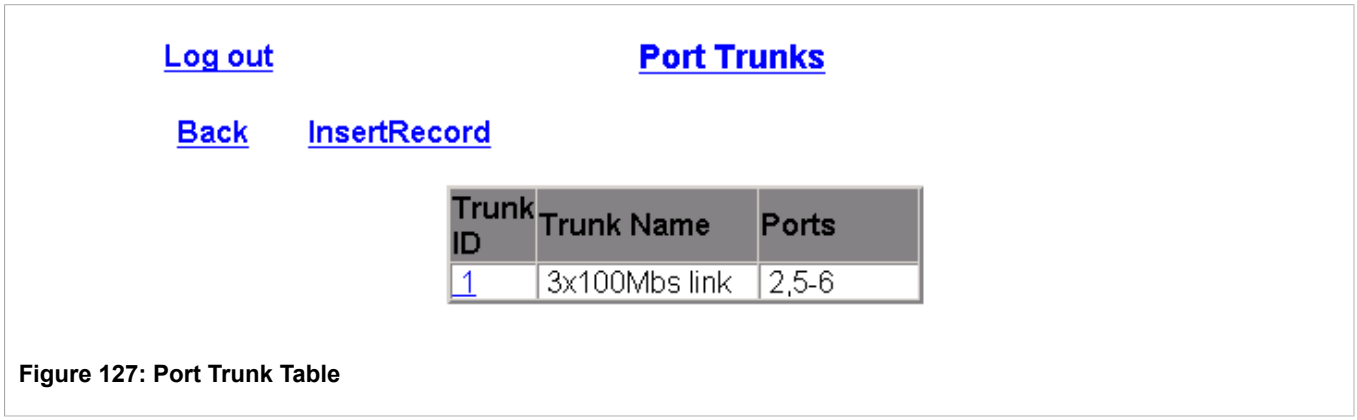


Figure 127: Port Trunk Table

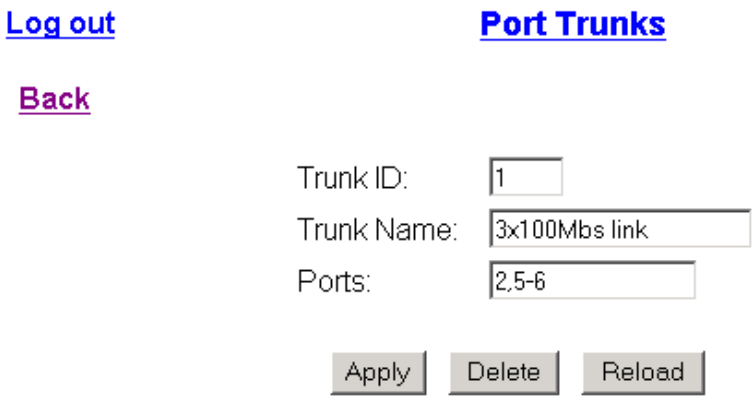


Figure 128: Port Trunk Form

Parameter	Description
Trunk ID	**Synopsis:** 1 to maximum number of port trunks **Default:** 1 Trunk number. It doesn't affect port trunk operation in any way and is only used for identification.
Trunk Name	**Synopsis:** Any 19 characters Default: Provides a description of the aggregated link purpose.
Ports	**Synopsis:** Any combination of numbers valid for this parameter **Default:** None List of ports aggregated in the trunk.

7 Spanning Tree

The RUGGEDCOM family of Ethernet switches provides the latest in IEEE standard Spanning Tree functionality, including:

- Industry standard support of Rapid Spanning Tree (802.1D-2004), which features a compatibility mode with legacy STP (802.1D-1998)
- Industry standard support of Multiple Spanning Trees (802.1Q-2005), which is interoperable with both RSTP and legacy STP.
- RUGGEDCOM RSTP feature enhancements (eRSTP™)
- Superior performance - RSTP will recognize a link failure and put an alternate port into forwarding within milliseconds
- RSTP may be enabled on a per-port basis
- Ports may be configured as edge ports, which allow rapid transitioning to the forwarding state for non-STP hosts
- Path costs may be hard-configured or determined by port speed negotiation, in either the STP or RSTP style
- Full bridge and port status displays provide a rich set of tools for performance monitoring and debugging

> **NOTE**
> *Historically, a device implementing STP on its ports has been referred to as a bridge. Siemens uses the terms "bridge" and "switch" synonymously.*

- SNMP-manageable including newRoot and topologyChange traps

Section 7.1

RSTP Operation

The 802.1D Spanning Tree Protocol (STP) was developed to enable the construction of robust networks that incorporate redundancy while pruning the active topology of the network to prevent loops. While STP is effective, it requires that frame transfer halt after a link outage until all bridges in the network are guaranteed to be aware of the new topology. Using the values recommended by 802.1D, this period lasts 30 seconds.

The Rapid Spanning Tree Protocol (RSTP, IEEE 802.1w) was a further evolution of the 802.1D Spanning Tree Protocol. It replaced the settling period with an active handshake between bridges that guarantees the rapid propagation of topology information throughout the network. RSTP also offers a number of other significant innovations, including:

- Topology changes in RSTP can originate from and be acted upon by any designated bridges, leading to more rapid propagation of address information, unlike topology changes in STP, which must be passed to the root bridge before they can be propagated to the network.
- RSTP explicitly recognizes two blocking roles - Alternate and Backup Port - which are included in computations of when to learn and forward. STP, however, recognizes only one state - Blocking - for ports that should not forward.
- RSTP bridges generate their own configuration messages, even if they fail to receive any from the root bridge. This leads to quicker failure detection. STP, by contrast, must relay configuration messages received on the

root port out its designated ports. If an STP bridge fails to receive a message from its neighbor, it cannot be sure where along the path to the root a failure occurred.

- RSTP offers edge port recognition, allowing ports at the edge of the network to forward frames immediately after activation, while at the same time protecting them against loops.

While providing much better performance than STP, IEEE 802.1w RSTP still required up to several seconds to restore network connectivity when a topology change occurred.

A revised and highly optimized RSTP version was defined in the IEEE standard 802.1D-2004 edition. IEEE 802.1D-2004 RSTP reduces network recovery times to just milliseconds and optimizes RSTP operation for various scenarios.

ROS supports IEEE 802.1D-2004 RSTP.

Section 7.1.1

RSTP States and Roles

RSTP bridges have roles to play, either root or designated. One bridge - the Root Bridge - is the logical center of the network. All other bridges in the network are Designated bridges.

RSTP also assigns each port of the bridge a state and a role. The RSTP state describes what is happening at the port in relation to address learning and frame forwarding. The RSTP role basically describes whether the port is facing the center or the edges of the network and whether it can currently be used.

State

There are three RSTP states: Discarding, Learning and Forwarding.

The discarding state is entered when the port is first put into service. The port does not learn addresses in this state and does not participate in frame transfer. The port looks for RSTP traffic in order to determine its role in the network. When it is determined that the port will play an active part in the network, the state will change to learning.

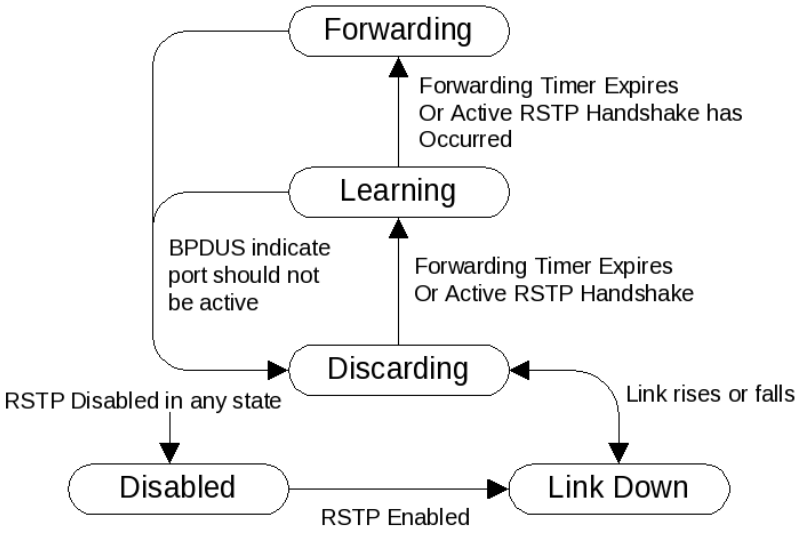


Figure 129: Bridge and Port States

The learning state is entered when the port is preparing to play an active part in the network. The port learns addresses in this state but does not participate in frame transfer. In a network of RSTP bridges, the time spent in this state is usually quite short. RSTP bridges operating in STP compatibility mode will spend six to 40 seconds in this state.

After “learning,” the bridge will place the port in the forwarding state. The port both learns addresses and participates in frame transfer while in this state.

NOTE
ROS introduces two more states - Disabled and Link Down. Introduced purely for purposes of management, these states may be considered subclasses of the RSTP Discarding state. The Disabled state refers to links for which RSTP has been disabled. The Link Down state refers to links for which RSTP is enabled but are currently down.

Role

There are four RSTP port roles: Root, Designated, Alternate and Backup.

If the bridge is not the root bridge, it must have a single Root Port. The Root Port is the “best” (i.e. quickest) way to send traffic to the root bridge.

A port is designated if it is the best port to serve the LAN segment it is connected to. All bridges on the same LAN segment listen to each others’ messages and agree on which bridge is the designated bridge. The ports of other bridges on the segment must become either root, alternate or backup ports.

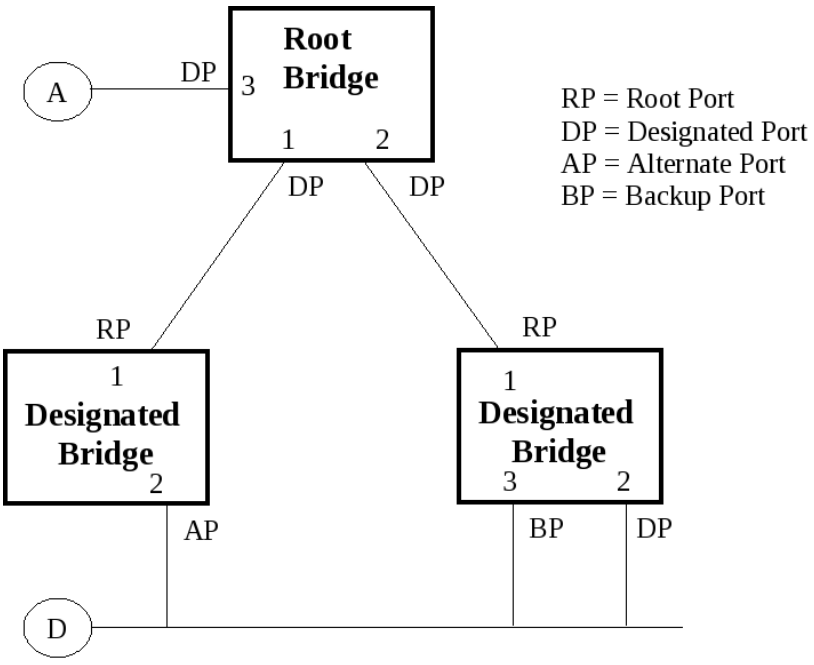


Figure 130: Bridge and Port Roles

A port is alternate when it receives a better message from another bridge on the LAN segment it is connected to. The message that an Alternate Port receives is better than the port itself would generate, but not good enough to convince it to become the Root Port. The port becomes the alternate to the current Root Port and will become the new Root Port should the current Root Port fail. The Alternate Port does not participate in the network.

A port is a Backup Port when it receives a better message from the LAN segment it is connected to, originating from another port on the same bridge. The port is a backup for another port on the bridge and will become active if that port fails. The Backup Port does not participate in the network.

Section 7.1.2
Edge Ports

A port may be designated an Edge Port if it is directly connected to an end station. As such, it cannot create bridging loops in the network and can thus directly transition to forwarding, skipping the listening and learning stages.

Edge ports that receive configuration messages immediately lose their Edge Port status and become normal spanning tree ports. A loop created on an improperly connected edge port is thus quickly repaired.

Because an Edge Port services only end stations, topology change messages are not generated when its link toggles.

Section 7.1.3
Point-to-Point and Multipoint Links

RSTP uses a peer-peer protocol called Proposing-Agreeing to ensure transitioning in the event of a link failure. This protocol is point-to-point and breaks down in multipoint situations, i.e. when more than two bridges operate on a shared media link.

If RSTP detects this circumstance (based upon the port's half duplex state after link up) it will switch off Proposing-Agreeing. The port must transition through the learning and forwarding states, spending one forward delay in each state.

There are circumstances in which RSTP will make an incorrect decision about the point-to-point state of the link simply by examining the half-duplex status, namely:

- The port attaches only to a single partner, but through a half-duplex link.
- The port attaches to a shared media hub through a full-duplex link. The shared media link attaches to more than one RSTP enabled bridge.

In such cases, the user may configure the bridge to override the half-duplex determination mechanism and force the link to be treated in the proper fashion.

Section 7.1.4
Path and Port Costs

The STP path cost is the main metric by which root and designated ports are chosen[1]. The path cost for a designated bridge is the sum of the individual port costs of the links between the root bridge and that designated bridge. The port with the lowest path cost is the best route to the root bridge and is chosen as the root port.

[1] In actuality the primary determinant for root port selection is the root bridge ID. Bridge ID is important mainly at network startup when the bridge with the lowest ID is elected as the root bridge. After startup (when all bridges agree on the root bridge's ID) the path cost is used to select root ports. If the path costs of candidates for the root port are the same, the ID of the peer bridge is used to select the port. Finally, if candidate root ports have the same path cost and peer bridge ID, the port ID of the peer bridge is used to select the root port. In all cases the lower ID, path cost or port ID is selected as the best.

How Port Costs Are Generated

Port costs can be generated either as a result of link auto-negotiation or manual configuration.

When the link auto-negotiation method is used, the port cost is derived from the speed of the link. This method is useful when a well-connected network has been established. It can be used when the designer is not too concerned with the resultant topology as long as connectivity is assured.

Manual configuration is useful when the exact topology of the network must be predictable under all circumstances. The path cost can be used to establish the topology of the network exactly as the designer intends.

STP vs. RSTP Costs

The IEEE 802.1D-1998 specification limits port costs to values of 1 to 65536. It recommends that a path cost corresponding to the 1x109 / link speed be used. Designed at a time when 9600 bps links were state of the art, this method breaks down in modern use, as the method cannot represent a link speed higher than a gigabit per second.

In order to remedy this problem in future applications the IEEE 802.1w specification limits port costs to values of 1 to 200000, with a path cost corresponding to the 2x1012 / link speed.

RUGGEDCOM bridges support interoperability with legacy STP bridges by selecting the style to use. In practice it makes no difference which style is used as long as it is applied consistently across the network, or if costs are manually assigned.

Section 7.1.5

Bridge Diameter

The bridge diameter is the maximum number of bridges between any two possible points of attachment of end stations to the network.

The bridge diameter reflects the realization that topology information requires time to propagate hop by hop through a network. If configuration messages take too long to propagate end to end through the network, the result will be an unstable network.

There is a relationship between the bridge diameter and the maximum age parameter[2]. To achieve extended ring sizes, RUGGEDCOM eRSTP™ uses an age increment of ¼ of a second. The value of the maximum bridge diameter is thus four times the configured maximum age parameter.

NOTE
Raise the value of the maximum age parameter if implementing very large bridged networks or rings.

Section 7.1.6

Fast Root Failover

Siemens's *Fast Root Failover* feature is an enhancement to RSTP that may be enabled or disabled via configuration. Fast Root Failover improves upon RSTP's handling of root bridge failures in mesh-connected networks, trading slightly increased failover times for a deterministic recovery time.

Two Fast Root Failover algorithms are available:

[2] The RSTP algorithm is as follows: STP configuration messages contain "age" information. Messages transmitted by the root bridge have an age of 0. As each subsequent designated bridge transmits the configuration message it must increase the age by at least 1 second. When the age exceeds the value of the maximum age parameter, the next bridge to receive the message immediately discards it.

- **robust:** guarantees a deterministic root failover time, but requires support from all switches in the network, including the root switch.
- **relaxed:** ensures a deterministic root failover time in most network configurations, but allows the use of a standard bridge in the root role.

NOTE
To use RSTP Fast Root Failover, all switches in the network must be RUGGEDCOM switches and must have the same Fast Root Failover algorithm enabled. In networks mixing RUGGEDCOM and non-RUGGEDCOM switches, or in those mixing Fast Root Failover algorithms, RSTP Fast Root Failover will not function properly and root bridge failure will result in an unpredictable failover time.

Fast Root Failover and RUGGEDCOM

- Running RSTP with Fast Root Failover disabled has no impact on RSTP performance.
- Fast Root Failover has no effect on RSTP performance in the case of failures that do not involve the root bridge or one of its links.
- The extra processing introduced by Fast Root Failover significantly decreases the worst-case failover time in mesh networks, with a modest increase in the best-case failover time. The effect on failover time in ring-connected networks, however, is only to increase it.

Recommendations On The Use Of Fast Root Failover

- It is not recommended to enable Fast Root Failover in single ring network topologies.
- It is strongly recommended to always connect the root bridge to each of its neighbor bridges using more than one link.

Section 7.2
MSTP Operation

The Multiple Spanning Tree (MST) algorithm and protocol provide greater control and flexibility than RSTP and legacy STP. MSTP (Multiple Spanning Tree Protocol) is an extension of RSTP, whereby multiple spanning trees may be maintained on the same bridged network. Data traffic is allocated to one or another of several spanning trees by mapping one or more VLANs onto the network.

NOTE
The sophistication and utility of the Multiple Spanning Tree implementation on a given bridged network is proportional to the amount of planning and design invested in configuring MSTP.

If MSTP is activated on some or all of the bridges in a network with no additional configuration, the result will be a fully and simply connected network, but at best, the result will be the same as a network using only RSTP. Taking full advantage of the features offered by MSTP requires a potentially large number of configuration variables to be derived from an analysis of data traffic on the bridged network, and from requirements for load sharing, redundancy, and path optimization. Once these parameters have all been derived, it is also critical that they are consistently applied and managed across all bridges in an MST region.

NOTE
By design, MSTP processing time is proportional to the number of active STP instances. This means that MSTP will likely be significantly slower than RSTP. Therefore, for mission critical applications, RSTP should be considered a better network redundancy solution than MSTP.

Section 7.2.1
MST Regions and Interoperability

In addition to supporting multiple spanning trees in a network of MSTP-capable bridges, MSTP is capable of interoperating with bridges that support only RSTP or legacy STP, without requiring any special configuration.

An MST region may be defined as the set of interconnected bridges whose MST Region Identification is identical (see Section 7.4.4, “MST Region Identifier”). The interface between MSTP bridges and non-MSTP bridges, or between MSTP bridges with different MST Region Identification information, becomes part of an MST Region boundary.

Bridges outside an MST region will see the entire region as though it were a single (R)STP bridge; the internal detail of the MST region is hidden from the rest of the bridged network. In support of this, MSTP maintains separate ‘hop counters’ for spanning tree information exchanged at the MST region boundary versus that propagated inside the region. For information received at the MST region boundary, the (R)STP Message Age is incremented only once. Inside the region, a separate Remaining Hop Count is maintained, one for each spanning tree instance. The external Message Age parameter is referred to the (R)STP Maximum Age Time, whereas the internal Remaining Hop Counts are compared to an MST region-wide Maximum Hops parameter.

MSTI

An MSTI (Multiple Spanning Tree Instance) is one of sixteen independent spanning tree instances that may be defined in an MST region (not including the IST – see below). An MSTI is created by mapping a set of VLANs (in ROS, via the VLAN configuration) to a given MSTI ID. The same mapping must be configured on all bridges that are intended to be part of the MSTI. Moreover, all VLAN to MSTI mappings must be identical for all bridges in an MST region.

NOTE
ROS supports 16 MSTIs in addition to the IST

Each MSTI has a topology that is independent of every other. Data traffic originating from the same source and bound to the same destination but on different VLANs on different MSTIs may therefore travel a different path across the network.

IST

An MST region always defines an IST (Internal Spanning Tree). The IST spans the entire MST region, and carries all data traffic that is not specifically allocated (by VLAN) to a specific MSTI. The IST is always computed and is defined to be MSTI zero.

The IST is also the extension inside the MST region of the CIST (see below), which spans the entire bridged network, inside and outside of the MST region and all other RSTP and STP bridges, as well as any other MST regions.

CST

The CST (Common Spanning Tree) spans the entire bridged network, including MST regions and any connected STP or RSTP bridges. An MST region is seen by the CST as an individual bridge, with a single cost associated with its traversal.

CIST

The CIST (Common and Internal Spanning Tree) is the union of the CST and the ISTs in all MST regions. The CIST therefore spans the entire bridged network, reaching into each MST region via the latter’s IST to reach every bridge on the network.

Section 7.2.2
MSTP Bridge and Port Roles

Section 7.2.2.1
Bridge Roles:

CIST Root
The CIST Root is the elected root bridge of the CIST (Common and Internal Spanning Tree), which spans all connected STP and RSTP bridges and MSTP regions.

CIST Regional Root
The root bridge of the IST within an MST region. The CIST Regional Root is the bridge within an MST region with the lowest cost path to the CIST Root. Note that the CIST Regional Root will be at the boundary of an MST region. Note also that it is possible for the CIST Regional Root to be the CIST Root.

MSTI Regional Root
The root bridge for an MSTI within an MST region. A root bridge is independently elected for each MSTI in an MST region.

Section 7.2.2.2
Port Roles:

Each port on an MST bridge may have more than one role depending on the number and topology of spanning tree instances defined on the port.

CIST Port Roles
- The Root Port provides the minimum cost path from the bridge to the CIST Root via the CIST Regional Root. If the bridge itself happens to be the CIST Regional Root, the Root Port is also the Master Port for all MSTIs (see below), and provides the minimum cost path to a CIST Root located outside the region.
- A Designated Port provides the minimum cost path from an attached LAN, via the bridge to the CIST Regional Root.
- Alternate and Backup Ports have the same sense that they do in RSTP, described in Section 7.1.1, “RSTP States and Roles”, under “Roles”, but relative to the CIST Regional Root.

MSTI Port Roles
For each MSTI on a bridge:
- The Root Port provides the minimum cost path from the bridge to the MSTI Regional Root, if the bridge itself is not the MSTI Regional Root.
- A Designated Port provides the minimum cost path from an attached LAN, via the bridge to the MSTI Regional Root.
- Alternate and Backup Ports have the same sense that they do in RSTP, described in Section 7.1.1, “RSTP States and Roles”, under “Roles”, but relative to the MSTI Regional Root.

The Master Port, which is unique in an MST region, is the CIST Root Port of the CIST Regional Root, and provides the minimum cost path to the CIST Root for all MSTIs.

Boundary Ports

A Boundary Port is a port on a bridge in an MST region that connects to either of: 1) a bridge belonging to a different MST region, or 2) a bridge supporting only RSTP or legacy STP. A Boundary Port blocks or forwards all VLANs from all MSTIs and the CIST alike. A Boundary Port may be:

- The CIST Root Port of the CIST Regional Root (and therefore also the MSTI Master Port).
- A CIST Designated Port, CIST Alternate / Backup Port, or Disabled. At the MST region boundary, the MSTI Port Role is the same as the CIST Port Role.

A Boundary Port connected to an STP bridge will send only STP BPDUs. One connected to an RSTP bridge need not refrain from sending MSTP BPDUs. This is made possible by the fact that the MSTP carries the CIST Regional Root Identifier in the field that RSTP parses as the Designated Bridge Identifier.

Section 7.2.3

Benefits of MSTP

Despite the fact that MSTP is configured by default to arrive automatically at a spanning tree solution for each configured MSTI, advantages may be gained from influencing the topology of MSTIs in an MST region. The fact that the Bridge Priority and each port cost are configurable per MSTI (see sections Section 7.4.5, “Bridge MSTI Parameters” and Section 7.4.6, “Port MSTI Parameters”) makes it possible to control the topology of each MSTI within a region.

Load Balancing

MST can be used to balance data traffic load among (sets of) VLANs, enabling more complete utilization of a multiply interconnected bridged network.

A bridged network controlled by a single spanning tree will block redundant links by design, in order to avoid harmful loops. Using MSTP, however, any given link may have a different blocking state for each spanning tree instance (MSTI), as maintained by MSTP. Any given link, therefore, might be in blocking state for some VLANS and in forwarding state for other VLANs, depending on the mapping of VLANs to MSTIs.

It is possible to control the spanning tree solution for each MSTI, especially the set of active links for each tree, by manipulating, per MSTI, the bridge priority and the port costs of links in the network. If traffic is allocated judiciously to multiple VLANs, redundant interconnections in a bridged network which, using a single spanning tree, would have gone unused, can now be made to carry traffic.

Isolation of Spanning Tree Reconfiguration

A link failure in an MST region that does not affect the roles of Boundary ports will not cause the CST to be reconfigured, nor will the change affect other MST regions. This is due to the fact that MSTP information does not propagate past a region boundary.

MSTP versus PVST

An advantage of MSTP over the Cisco Systems Inc. proprietary PVST protocol is the ability to map multiple VLANs onto a single MSTI. Since each spanning tree requires processing and memory, the expense of keeping track of an increasing number of VLANs increases much more rapidly for PVST than for MSTP.

Compatibility with STP and RSTP

No special configuration is required for the bridges of an MST region to connect fully and simply to non-MST bridges on the same bridged network. Careful planning and configuration is, however, recommended in order to arrive at an optimal network.

Section 7.2.4
Implementing MSTP on a Bridged Network

It is recommended that the configuration of MSTP on a network proceed in the sequence outlined below. Naturally, it is also recommended that network analysis and planning inform the steps of configuring the VLAN and MSTP parameters in particular.

Begin with a set of MSTP-capable Ethernet bridges, and MSTP disabled. For each bridge in the network:

1. Configure and enable RSTP (see sections Section 7.4.1, “Bridge RSTP Parameters” and Section 7.4.2, “Port RSTP Parameters”). Note that the Max Hops parameter in the Bridge RSTP Parameters menu is the maximum hop count for MSTP
2. Create the VLANs that will be mapped to MSTIs (see the sections on VLAN Configuration)
3. Map VLANs to MSTIs (via the VLAN Configuration menus). Note that MSTP need not be enabled in order to map a VLAN to an MSTI. Note also that this mapping must be identical for each bridge that is to belong to the MST region
4. Configure a Region Identifier and Revision Level. Note that these two items must be identical for each bridge in the MST region (see Section 7.4.4, “MST Region Identifier”)
5. Verify that the Digest field in the MST Region Identifier menu is identical for each bridge in the MST region. If it is not, then the set of mappings from VLANs to MSTIs differs
6. Configure Bridge Priority per MSTI (see Section 7.4.5, “Bridge MSTI Parameters”)
7. Configure Port Cost and Priority per port and per MSTI (see Section 7.4.6, “Port MSTI Parameters”)
8. Enable MSTP (see Section 7.4.1, “Bridge RSTP Parameters”)

NOTE
Static VLANs must be used in an MSTP configuration. GVRP is not supported in this case.

Section 7.3
RSTP Applications

Section 7.3.1
RSTP in Structured Wiring Configurations

RSTP allows you to construct structured wiring systems in which connectivity is maintained in the event of link failures. For example, a single link failure of any of links A through N in Figure 131, “Example of a Structured Wiring Configuration”, would leave all the ports of bridges 555 through 888 connected to the network.

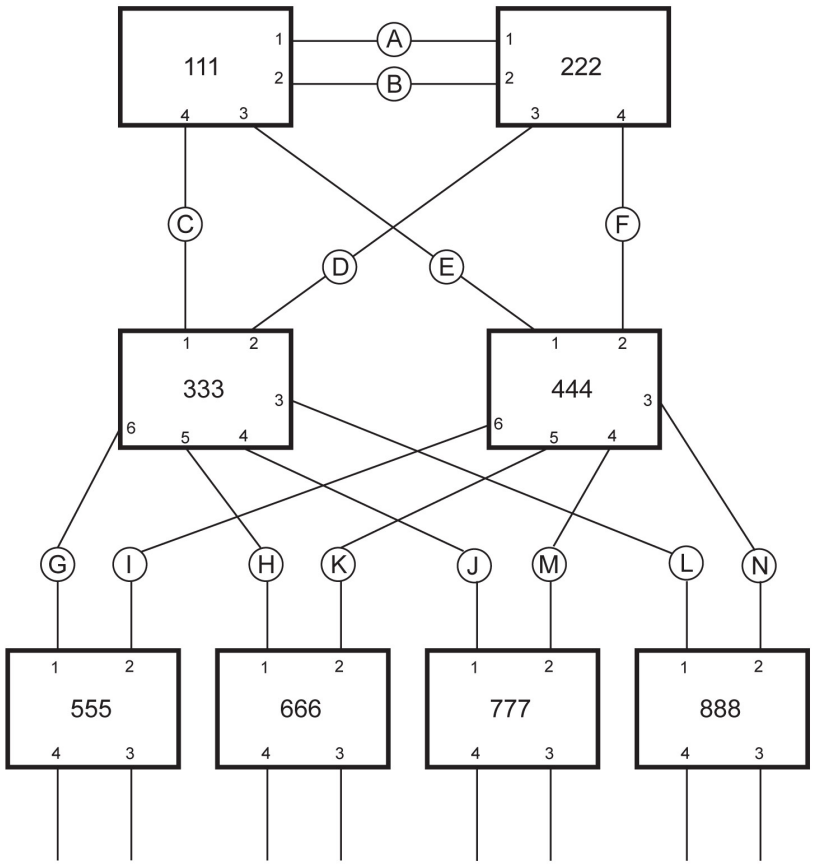


Figure 131: Example of a Structured Wiring Configuration

Procedure: Design Considerations for RSTP in Structured Wiring Configurations

1. **Select the design parameters for the network.**

   What are the requirements for robustness and network fail-over/recovery times? Are there special requirements for diverse routing to a central host computer? Are there any special port redundancy requirements?

2. **Identify required legacy support.**

   Are STP bridges used in the network? These bridges do not support rapid transitioning to forwarding. If these bridges are present, can they be re-deployed closer to the network edge?

3. **Identify edge ports and ports with half-duplex/shared media restrictions.**

   Ports that connect to host computers, IEDs and controllers may be set to edge ports in order to guarantee rapid transitioning to forwarding as well as to reduce the number of topology change notifications in the network. Ports with half-duplex/shared media restrictions require special attention in order to guarantee that they do not cause extended fail-over/recovery times.

4. **Choose the root bridge and backup root bridge carefully.**

   The root bridge should be selected to be at the concentration point of network traffic. Locate the backup root bridge adjacent to the root bridge. One strategy that may be used is to tune the bridge priority to establish the root bridge and then tune each bridge's priority to correspond to its distance from the root bridge.

5. **Identify desired steady state topology.**

   Identify the desired steady state topology taking into account link speeds, offered traffic and QOS. Examine of the effects of breaking selected links, taking into account network loading and the quality of alternate links.

6. **Decide upon port cost calculation strategy.**

   Select whether fixed or auto-negotiated costs should be used? Select whether the STP or RSTP cost style should be used.

7. **Calculate and configure priorities and costs.**

8. **Implement the network and test under load.**

Section 7.3.2

RSTP in Ring Backbone Configurations

RSTP may be used in ring backbone configurations where rapid recovery from link failure is required. In normal operation, RSTP will block traffic on one of the links, for example as indicated by the double bars through link H in Figure 132, “Example of a Ring Backbone Configuration”. In the event of a failure on link D, bridge 444 will unblock link H. Bridge 333 will communicate with the network through link F.

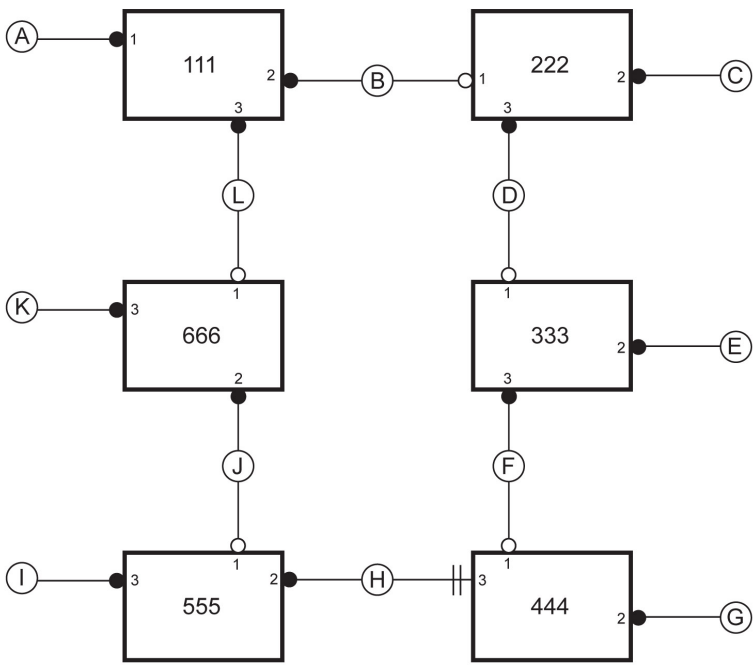


Figure 132: Example of a Ring Backbone Configuration

Procedure: Design Considerations for RSTP in Ring Backbone Configurations

1. **Select the design parameters for the network.**

   What are the requirements for robustness and network fail-over/recovery times? Typically, ring backbones are chosen to provide cost effective but robust network designs.

2. **Identify required legacy support and ports with half-duplex/shared media restrictions.**

   These bridges should not be used if network fail-over/recovery times are to be minimized.

3. **Identify edge ports**

   Ports that connect to host computers, IEDs and controllers may be set to edge ports in order to guarantee rapid transitioning to forwarding as well as to reduce the number of topology change notifications in the network.

4. **Choose the root bridge.**

   The root bridge can be selected to equalize either the number of bridges, number of stations or amount of traffic on either of its legs. It is important to realize that the ring will always be broken in one spot and that traffic always flows through the root.

5. **Assign bridge priorities to the ring.**

   The strategy that should be used is to assign each bridge's priority to correspond to its distance from the root bridge. If the root bridge is assigned the lowest priority of 0, the bridges on either side should use a priority of 4096 and the next bridges 8192 and so on. As there are 16 levels of bridge priority available, this method provides for up to 31 bridges in the ring.

6. **Implement the network and test under load.**

Section 7.3.3

RSTP Port Redundancy

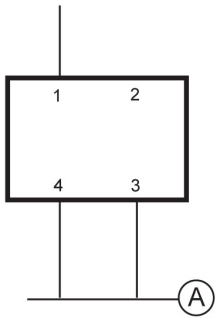


Figure 133: Port Redundancy

In cases where port redundancy is essential, RSTP allows more than one bridge port to service a LAN. For example, if port 3 is designated to carry the network traffic of LAN A, port 4 will block. Should an interface failure occur on port 3, port 4 would assume control of the LAN.

Section 7.4

Spanning Tree Configuration

The Spanning Tree menu is accessible from the main menu.

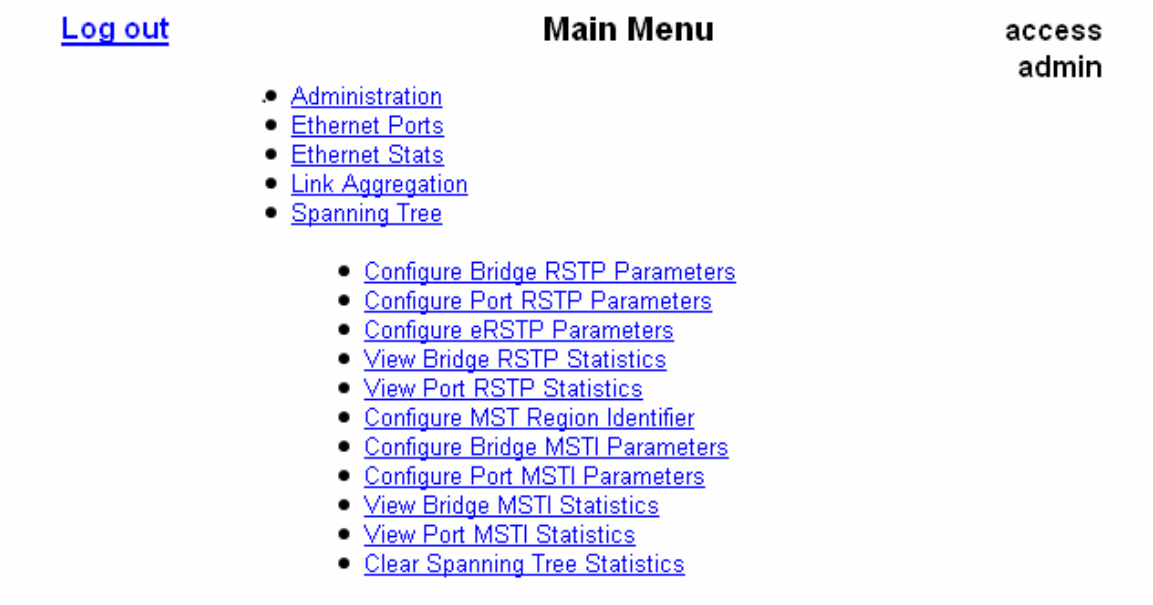


Figure 134: Spanning Tree Menu

Section 7.4.1

Bridge RSTP Parameters

The Bridge RSTP Parameter form configures RSTP bridge-level parameters.

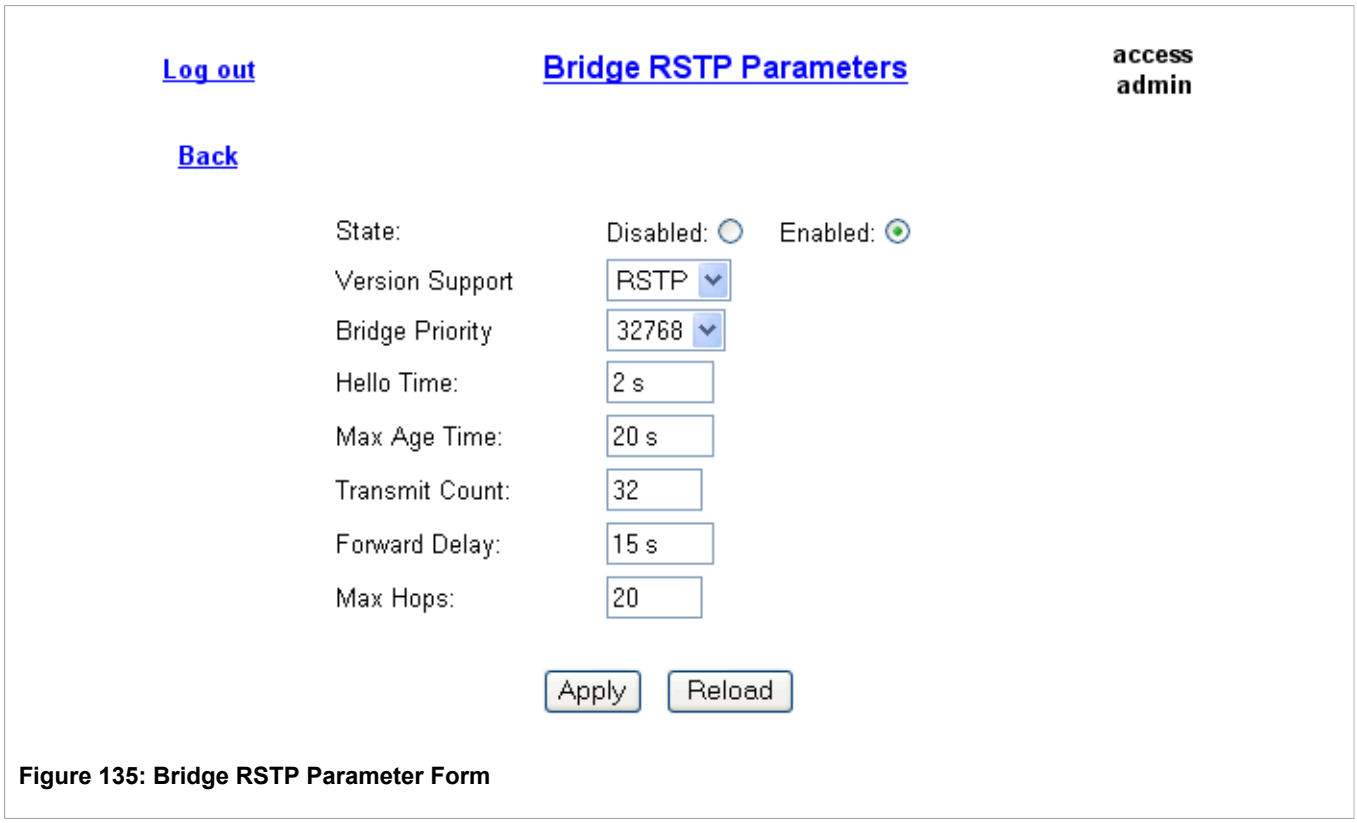


Figure 135: Bridge RSTP Parameter Form

Parameter	Description
State	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enable STP/RSTP/MSTP for the bridge globally. Note that for STP/RSTP/MSTP to be enabled on a particular port, it must be enabled both globally and per port.
Version Support	**Synopsis:** { STP, RSTP, MSTP } **Default:** RSTP Selects the version of Spanning Tree Protocol to support one of: STP, Rapid STP, or Multiple STP.
Bridge Priority	**Synopsis:** { 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, 61440 } **Default:** 32768 Bridge Priority provides a way to control the topology of the STP connected network. The desired Root and Designated bridges can be configured for a particular topology. The bridge with the lowest priority will become the root. In the event of a failure of the root bridge, the bridge with the next lowest priority will then become the root. Designated bridges that (for redundancy purposes) service a common LAN also use priority to determine which bridge is active. In this way, careful selection of Bridge Priorities can establish the path of traffic flows in normal and abnormal conditions.
Hello Time	**Synopsis:** 1 s to 10 s **Default:** 2 s The time between configuration messages issued by the root bridge. Shorter hello times result in faster detection of topology changes at the expense of moderate increases in STP traffic.
Max Age Time	**Synopsis:** 6 s to 40 s **Default:** 20 s

Parameter	Description
	The time for which a configuration message remains valid after being issued by the root bridge. Configure this parameter with care when many tiers of bridges exist, or when slow speed links (such as those used in WANs) are part of the network.
Transmit Count	**Synopsis:** 3 to 100 or { Unlimited } **Default:** Unlimited The maximum number of BPDUs on each port that may be sent in one second. Larger values allow the network to recover from failed links/bridges more quickly.
Forward Delay	**Synopsis:** 4 s to 30 s **Default:** 15 s The amount of time a bridge spends learning MAC addresses on a rising port before beginning to forward traffic. Lower values allow the port to reach the forwarding state more quickly, but at the expense of flooding unlearned addresses to all ports.
Max Hops	**Synopsis:** 6 to 40 **Default:** 20 This parameter is only relevant for MSTP - ignore it otherwise.This parameter specifies the maximum possible bridge diameter inside an MST region. MSTP BPDUs propagating inside an MST region carry a time-to-live parameter that is decremented by every switch that propagates the BPDU. If the maximum number of hops inside the region exceeds the configured maximum, BPDUs may be discarded due to their time-to-live information.

Section 7.4.2

Port RSTP Parameters

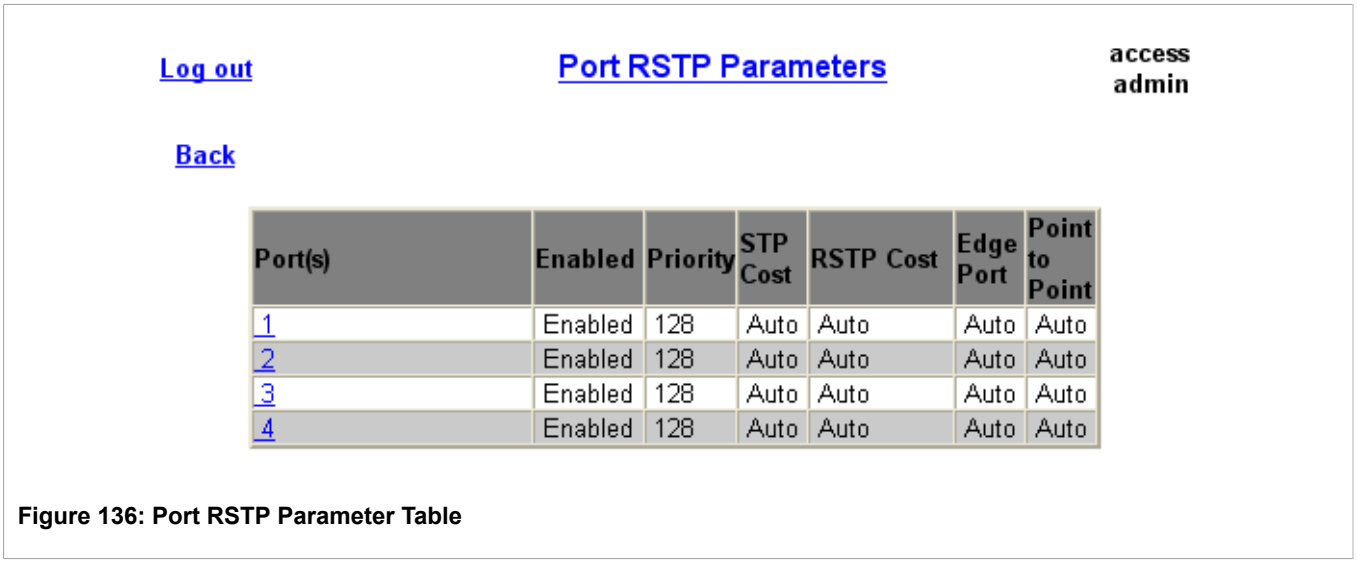


Figure 136: Port RSTP Parameter Table

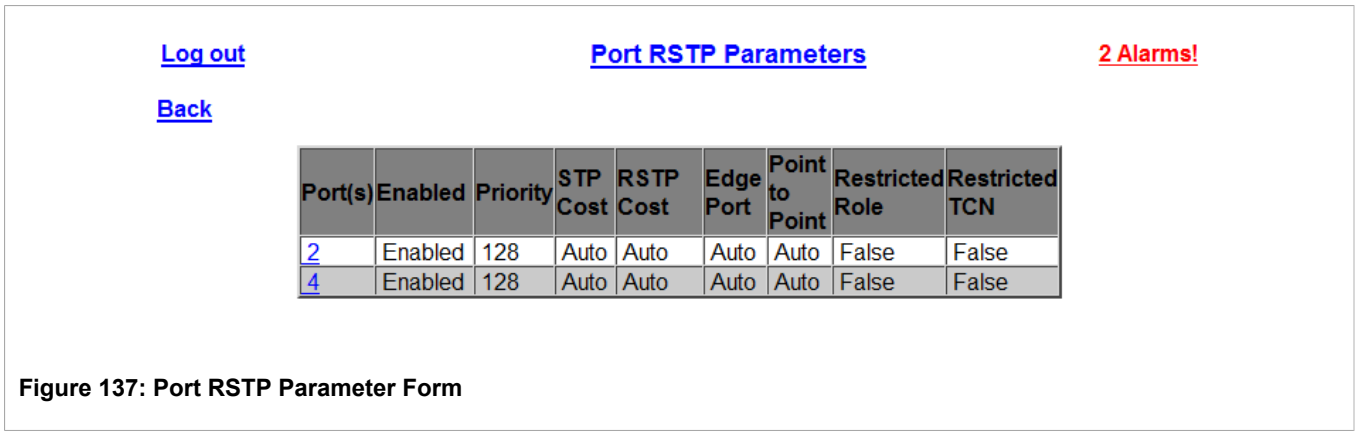

Log out
Port RSTP Parameters
2 Alarms!
Back
Port(s) Enabled Priority STP Cost RSTP Cost Edge Port Point to Point Restricted Role Restricted TCN
2 Enabled 128 Auto Auto Auto Auto False False
4 Enabled 128 Auto Auto Auto Auto False False

Figure 137: Port RSTP Parameter Form

Parameter	Description
Port(s)	**Synopsis:** Any combination of numbers valid for this parameter The port number as seen on the front plate silkscreen of the switch (or a list of ports, if aggregated in a port trunk).
Enabled	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enabling STP activates the STP or RSTP protocol for this port per the configuration in the STP Configuration menu. STP may be disabled for the port ONLY if the port does not attach to an STP enabled bridge in any way. Failure to meet this requirement WILL result in an undetectable traffic loop in the network. A better alternative to disabling the port is to leave STP enabled but to configure the port as an edge port. A good candidate for disabling STP would be a port that services only a single host computer.
Priority	**Synopsis:** { 0, 16, 32, 48, 64, 80, 96, 112, 128, 144, 160, 176, 194, 208, 224, 240 } **Default:** 128 Selects the STP port priority. Ports of the same cost that attach to a common LAN will select the port to be used based upon the port priority.
STP Cost	**Synopsis:** 0 to 65535 or { Auto } **Default:** Auto Selects the cost to use in cost calculations, when the Cost Style parameter is set to STP in the Bridge RSTP Parameters configuration. Setting the cost manually provides the ability to preferentially select specific ports to carry traffic over others. Leave this field set to "auto" to use the standard STP port costs as negotiated (4 for 1Gbps, 19 for 100 Mbps links and 100 for 10 Mbps links). For MSTP, this parameter applies to both external and internal path cost.
RSTP Cost	**Synopsis:** 0 to 2147483647 or { Auto } **Default:** Auto Selects the cost to use in cost calculations, when the Cost Style parameter is set to RSTP in the Bridge RSTP Parameters configuration. Setting the cost manually provides the ability to preferentially select specific ports to carry traffic over others. Leave this field set to "auto" to use the standard RSTP port costs as negotiated (20,000 for 1Gbps, 200,000 for 100 Mbps links and 2,000,000 for 10 Mbps links). For MSTP, this parameter applies to both external and internal path cost.
Edge Port	**Synopsis:** { False, True, Auto } **Default:** Auto Edge ports are ports that do not participate in the Spanning Tree, but still send configuration messages. Edge ports transition directly to frame forwarding without any listening and learning delays. The MAC tables of Edge ports do not need to be flushed when topology changes occur in the STP network. Unlike an STP disabled port, accidentally connecting an edge port to another port in the spanning tree will result in a detectable loop. The

Parameter	Description
	"Edgeness" of the port will be switched off and the standard RSTP rules will apply (until the next link outage).
Point to Point	**Synopsis:** { False, True, Auto } **Default:** Auto RSTP uses a peer-to-peer protocol that provides rapid transitioning on point-to-point links. This protocol is automatically turned off in situations where multiple STP bridges communicate over a shared (non point-to-point) LAN. The bridge will automatically take point-to-point to be true when the link is found to be operating in full-duplex mode. The point-to-point parameter allows this behavior or overrides it, forcing point-to-point to be true or false. Force the parameter true when the port operates a point-to-point link but cannot run the link in full-duplex mode. Force the parameter false when the port operates the link in full-duplex mode, but is still not point-to-point (e.g. a full-duplex link to an unmanaged bridge that concentrates two other STP bridges).
Restricted Role	**Synopsis:** { True or False } **Default:** False A boolean value set by management. If TRUE, causes the Port not to be selected as the Root Port for the CIST or any MSTI, even if it has the best spanning tree priority vector. Such a Port will be selected as an Alternate Port after the Root Port has been selected. This parameter should be FALSE by default. If set, it can cause a lack of spanning tree connectivity. It is set by a network administrator to prevent bridges that are external to a core region of the network from influencing the spanning tree active topology. This may be necessary, for example, if those bridges are not under the full control of the administrator.
Restricted TCN	**Synopsis:** { True or False } **Default:** False A boolean value set by management. If TRUE, it causes the Port not to propagate received topology change notifications and topology changes to other Ports. If set, it can cause temporary loss of connectivity after changes in a spanning tree's active topology as a result of persistent, incorrectly learned, station location information. It is set by a network administrator to prevent bridges that are external to a core region of the network from causing address flushing in that region. This may be necessary, for example, if those bridges are not under the full control of the administrator or if the MAC_Operational status parameter for the attached LANs transitions frequently.

Section 7.4.3
eRSTP Parameters

The eRSTP Parameter form configures parameters relevant to different eRSTP enhancements.

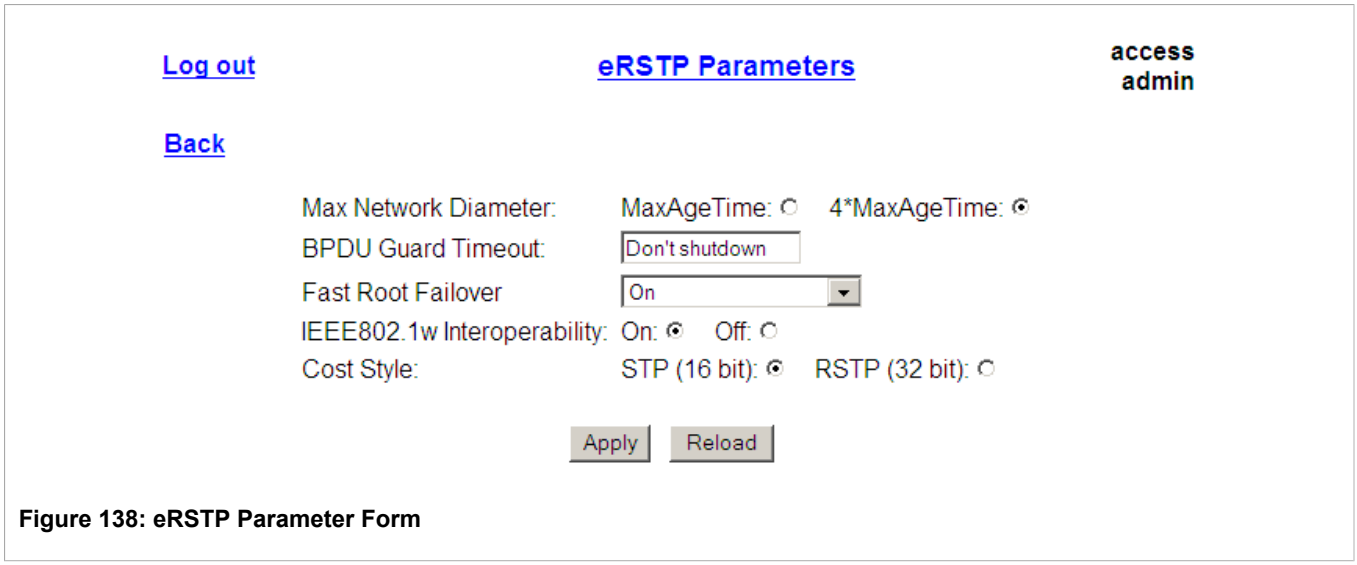


Figure 138: eRSTP Parameter Form

Parameter	Description
Max Network Diameter	**Synopsis:** { MaxAgeTime, 4*MaxAgeTime } **Default:** 4*MaxAgeTime The RSTP standard puts a limit on the maximum network size that can be controlled by the RSTP protocol. The network size is described by the term ‘maximum network diameter’, which is the number of switches that comprise the longest path that RSTP BPDUs have to traverse. The standard supported maximum network diameter is equal to the value of the ‘MaxAgeTime’ RSTP configuration parameter. eRSTP offers an enhancement to RSTP which allows it to cover networks larger than ones defined by the standard. This configuration parameter selects the maximum supported network size.
BPDU Guard Timeout	**Synopsis:** 1 to 86400 s or { Until reset, Don’t shutdown } **Default:** Don’t shutdown The RSTP standard does not address network security. RSTP must process every received BPDU and take appropriate action. This opens a way for an attacker to influence RSTP topology by injecting RSTP BPDUs into the network. "BPDU Guard" is a feature that protects the network from BPDUs received by a port to which RSTP capable devices are not expected to be attached. If a BPDU is received by a port for which the ‘Edge’ parameter is set to ‘TRUE’ or RSTP is disabled, the port will be shut down for the time period specified by this parameter. • DON’T SHUTDOWN - BPDU Guard is disabled. • UNTIL RESET - port will remain shut down until the port reset command is issued by the operator.
Fast Root Failover	**Synopsis:** { On, On with standard root, Off } **Default:** On In mesh network topologies, the standard RSTP algorithm does not guarantee deterministic network recovery time in the case of a root bridge failure. Such a recovery time is hard to calculate and it can be different (and may be relatively long) for any given mesh topology. This configuration parameter enables Siemens’s enhancement to RSTP which detects a failure of the root bridge and takes some extra RSTP processing steps, significantly reducing the network recovery time and making it deterministic. To guarantee optimal performance, the Fast Root Failover algorithm must be supported by all switches in the network, including the root. However, it is not uncommon to assign the root role to a switch from a vendor different from the rest of the switches in the network. In this case, it is possible that the root might not support the Fast Root Failover algorithm. In this scenario, use the “relaxed” algorithm, which tolerates the lack of algorithm support in the root switch. The following are the supported configuration options:

Parameter	Description
	• On – Fast Root Failover is enabled and the most robust algorithm is used, which requires the appropriate support in the root switch. • On with standard root – Fast Root Failover is enabled but a “relaxed” algorithm is used, allowing the use of a standard switch in the root role. • Off – Fast Root Failover algorithm is disabled and hence a root switch failure may result in excessive connectivity recovery time. **NOTE** *This feature is only available in RSTP mode. In MSTP mode, the configuration parameter is ignored. In a single ring topology, this feature is not needed and should be disabled to avoid longer network recovery times due to extra RSTP processing. For recommendations regarding the use of this feature, refer to Section 7.1.6, “Fast Root Failover”.*
IEEE802.1w Interoperability	**Synopsis:** { On, Off } **Default:** On The original RSTP protocol defined in the IEEE 802.1w standard has minor differences from more recent, enhanced, standard(s). Those differences cause interoperability issues which, although they do not completely break RSTP operation, can lead to a longer recovery time from failures in the network. eRSTP offers some enhancements to the protocol which make the switch fully interoperable with other vendors’ switches, which may be running IEEE 802.2w RSTP. The enhancements do not affect interoperability with more recent RSTP editions. This configuration parameter enables the aforementioned interoperability mode.
Cost Style	**Synopsis:** { STP (16 bit), RSTP (32 bit) } **Default:** STP (16 bit) The RSTP standard defines two styles of a path cost value. STP uses 16-bit path costs based on 1x10E9/link speed (4 for 1Gbps, 19 for 100 Mbps and 100 for 10 Mbps) whereas RSTP uses 32-bit costs based upon 2x10E13/link speed (20,000 for 1Gbps, 200,000 for 100 Mbps and 2,000,000 for 10 Mbps). Switches from some vendors, however, use the STP path cost style even in RSTP mode, which can cause confusion and problems with interoperability. This configuration parameter selects the style of path cost to employ. Note that RSTP path costs are used only when the bridge version support is set to allow RSTP and the port does not migrate to STP.

Section 7.4.4

MST Region Identifier

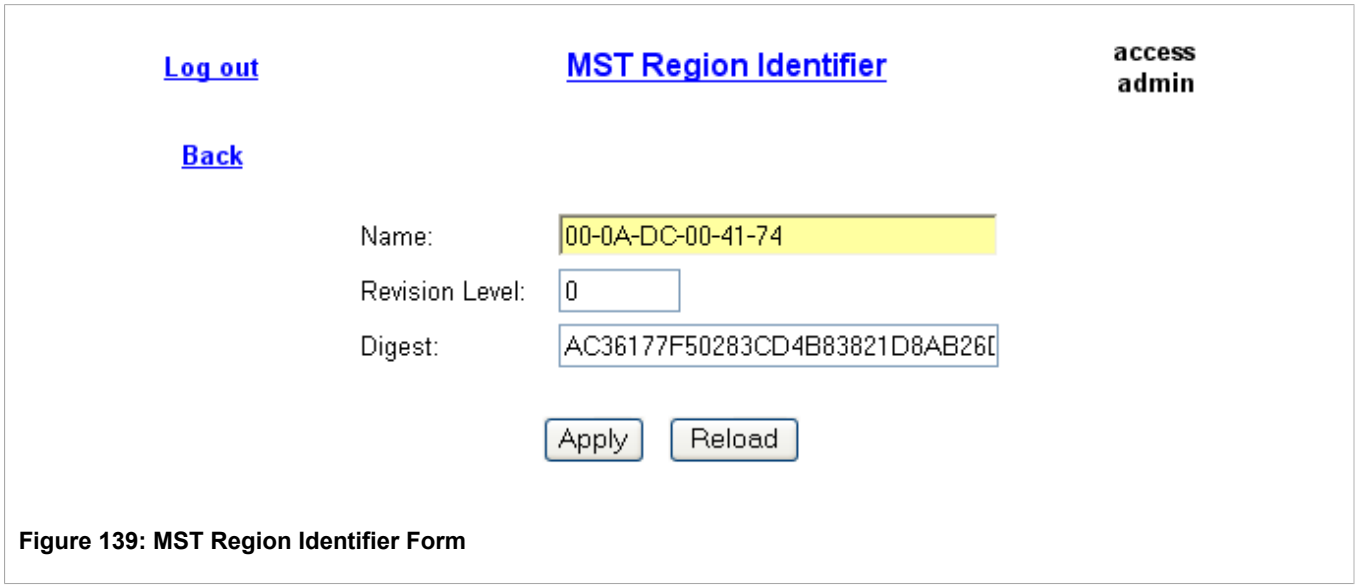


Figure 139: MST Region Identifier Form

Parameter	Description
Name	**Synopsis:** Any 32 characters **Default:** 00-0A-DC-00-41-74 Variable length text string. You must configure an identical region name on all switches you want to be in the same MST region.
Revision Level	**Synopsis:** 0 to 65535 **Default:** 0 Use this parameter, if you want to create a new region from a subset of switches in a current region, while maintaining the same region name.
Digest	**Synopsis:** 32 hex characters This is a read-only parameter and should be only used for network troubleshooting. In order to ensure consistent VLAN-to-instance mapping, it is necessary for the protocol to be able to exactly identify the boundaries of the MST regions. For that purpose, the characteristics of the region are included in BPDUs. There is no need to propagate the exact VLAN-to-instance mapping in the BPDUs because switches only need to know whether they are in the same region as a neighbor. Therefore, only this 16-octet digest created from the VLAN-to-instance mapping is sent in BPDUs.

Section 7.4.5

Bridge MSTI Parameters

Figure 140: Bridge MSTI Parameters

Parameter	Description
Instance ID	**Synopsis:** 0 to 16 **Default:** 1 The Instance ID refers to the MSTI (Multiple Spanning Tree Instance) ID. Specify an Instance ID and select GET in order to load the parameters of the page corresponding to the selected MSTI. Changes to parameters that are subsequently applied will apply to the selected Instance ID. Note: Bridge Parameters for the IST (MSTI zero) are accessible via the Bridge RSTP Parameters menu (see Section 7.4.1, “Bridge RSTP Parameters”).
Bridge Priority	**Synopsis:** { 0, 4096, 8192, 12288, 16384, 20480, 24576, 28672, 32768, 36864, 40960, 45056, 49152, 53248, 57344, 61440 } **Default:** 32768 Bridge Priority provides a way to control the topology of the STP connected network. The desired Root and Designated bridges can be configured for a particular topology. The bridge with the lowest priority will become root. In the event of a failure of the root bridge, the bridge with the next lowest priority will then become root. Designated bridges that (for redundancy purposes) service a common LAN also use priority to determine which bridge is active. In this way careful selection of Bridge Priorities can establish the path of traffic flows in both normal and abnormal conditions.

Section 7.4.6

Port MSTI Parameters

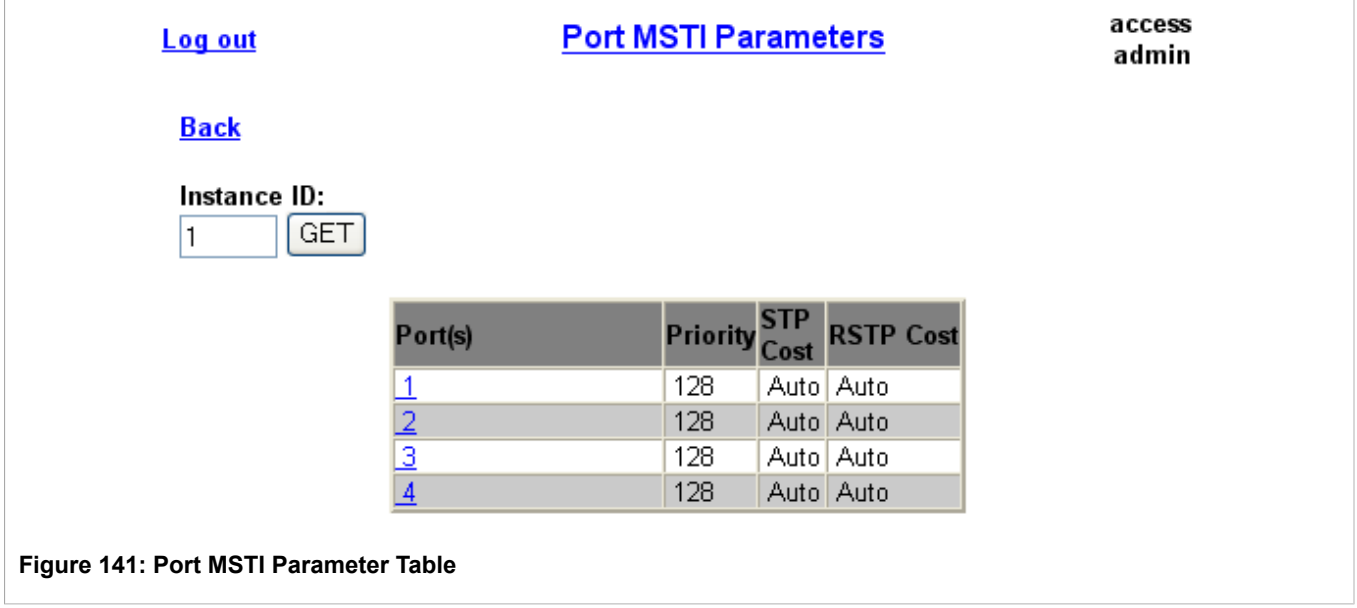


Figure 141: Port MSTI Parameter Table

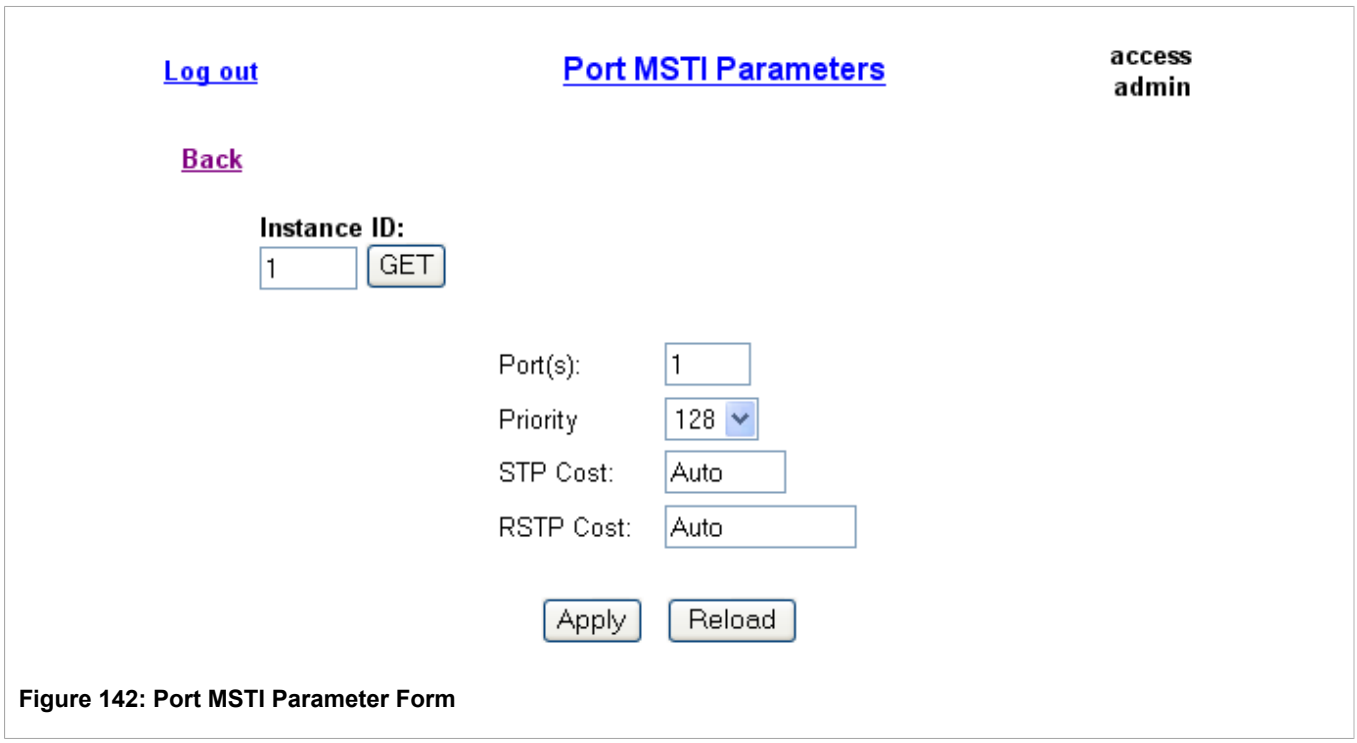


Figure 142: Port MSTI Parameter Form

Parameter	Description
Instance ID	**Synopsis:** 0 to 16 **Default:** 1 The Instance ID refers to the MSTI (Multiple Spanning Tree Instance) ID. Specify an Instance ID and select GET in order to load parameters corresponding to the selected MSTI. Changes to parameters that are subsequently applied will apply to the selected

Parameter	Description
	Instance ID. Note: Port Parameters for the IST (MSTI zero), are accessible via the Port RSTP Parameters menu (see Section 7.4.2, “Port RSTP Parameters”).
Port(s)	**Synopsis:** Any combination of numbers valid for this parameter The port number as seen on the front plate silkscreen of the switch (or a list of ports, if aggregated in a port trunk).
Priority	**Synopsis:** { 0, 16, 32, 48, 64, 80, 96, 112, 128, 144, 160, 176, 194, 208, 224, 240 } **Default:** 128 Selects the STP port priority. Ports of the same cost that attach to a common LAN will select the port to be used based on the port priority.
STP Cost	**Synopsis:** 0 to 65535 or { Auto } **Default:** Auto Selects the cost to use in cost calculations when the Cost Style parameter is set to STP in the Bridge RSTP Parameters configuration. Setting the cost manually provides the ability to preferentially select specific ports to carry traffic over others. Leave this field set to "auto" to use the standard STP port costs as negotiated (4 for 1Gbps, 19 for 100 Mbps links and 100 for 10 Mbps links). For MSTP, this parameter applies to both external and internal path cost.
RSTP Cost	**Synopsis:** 0 to 2147483647 or { Auto } **Default:** Auto Selects the cost to use in cost calculations when the Cost Style parameter is set to RSTP in the Bridge RSTP Parameters configuration. Setting the cost manually provides the ability to preferentially select specific ports to carry traffic over others. Leave this field set to "auto" to use the standard RSTP port costs as negotiated (20,000 for 1Gbps, 200,000 for 100 Mbps links and 2,000,000 for 10 Mbps links). For MSTP, this parameter applies to both external and internal path cost.

Section 7.5
Spanning Tree Statistics

Section 7.5.1
Bridge RSTP Statistics

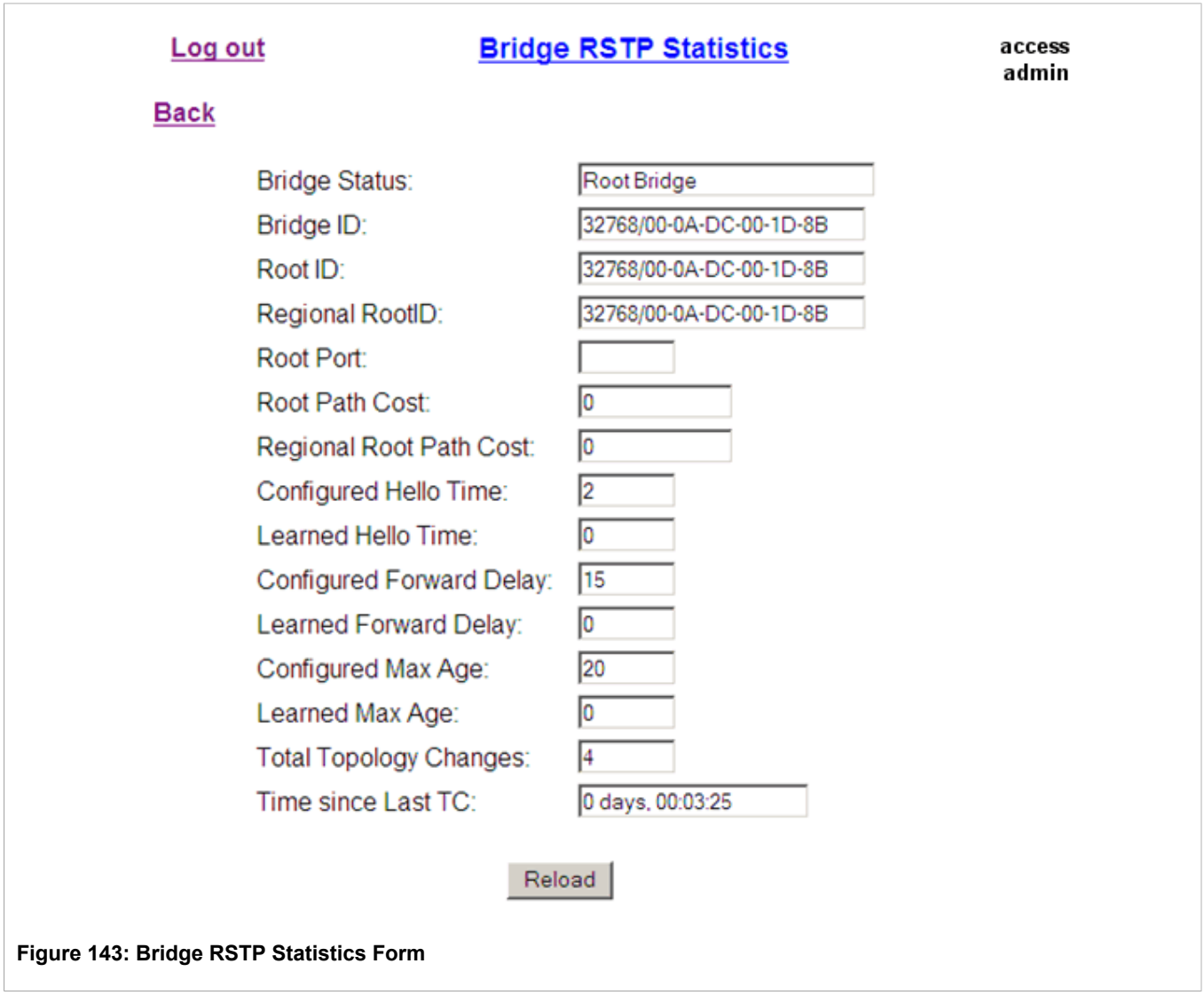


Figure 143: Bridge RSTP Statistics Form

Parameter	Description
Bridge Status	**Synopsis:** { <empty string>, Designated Bridge, Not Designated For Any LAN, Root Bridge } Spanning Tree status of the bridge. The status may be root or designated. This field may display "Not designated For Any LAN" if the bridge is not the designated bridge for any of its ports.
Bridge ID	**Synopsis:** $$ / ##-##-##-##-##-## where $$ is 0 to 65535, ## is 0 to FF Bridge Identifier of this bridge.

Parameter	Description
Root ID	**Synopsis:** $$ / ##-##-##-##-##-## where $$ is 0 to 65535, ## is 0 to FF Bridge Identifier of the root bridge.
Regional Root ID	**Synopsis:** $$ / ##-##-##-##-##-## where $$ is 0 to 65535, ## is 0 to FF Bridge Identifier of the IST regional root bridge for the MST region this device belongs to.
Root Port	**Synopsis:** 0 to 65535 or { <empty string>} If the bridge is designated, this is the port that provides connectivity towards the root bridge of the network.
Root Path Cost	**Synopsis:** 0 to 4294967295 The total cost of the path to the root bridge, composed of the sum of the costs of each link in the path. If custom costs have not been configured. 1Gbps ports will contribute a cost of four, 100 Mbps ports will contribute 19 and 10 Mbps ports will contribute 100. For the CIST instance of MSTP, this is an external root path cost, which is the cost of the path from the IST root (i.e. regional root) bridge to the CST root (i.e. network "global" root) bridge.
Configured Hello Time	**Synopsis:** 0 to 65535 The configured Hello time from the Bridge RSTP Parameters menu.
Learned Hello Time	**Synopsis:** 0 to 65535 The actual Hello time provided by the root bridge as learned in configuration messages. This time is used in designated bridges.
Configured Forward Delay	**Synopsis:** 0 to 65535 The configured Forward Delay time from the Bridge RSTP Parameters menu.
Learned Forward Delay	**Synopsis:** 0 to 65535 The actual Forward Delay time provided by the root bridge as learned in configuration messages. This time is used in designated bridges.
Configured Max Age	**Synopsis:** 0 to 65535 The configured Maximum Age time from the Bridge RSTP Parameters menu.
Learned Max Age	**Synopsis:** 0 to 65535 The actual Maximum Age time provided by the root bridge as learned in configuration messages. This time is used in designated bridges.
Total Topology Changes	**Synopsis:** 0 to 65535 A count of topology changes in the network, as detected on this bridge through link failures or as signaled from other bridges. Excessively high or rapidly increasing counts signal network problems.
Time since Last TC	**Synopsis:** D days, HH:MM:SS Displays the time since the last topology change.

Section 7.5.2

Port RSTP Statistics

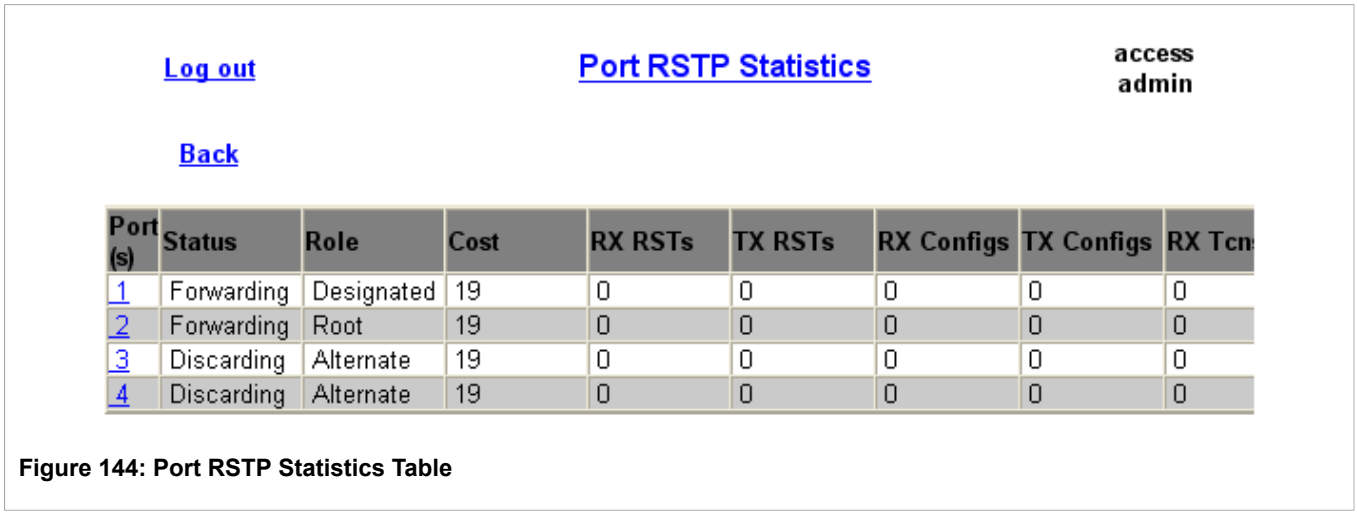


Figure 144: Port RSTP Statistics Table

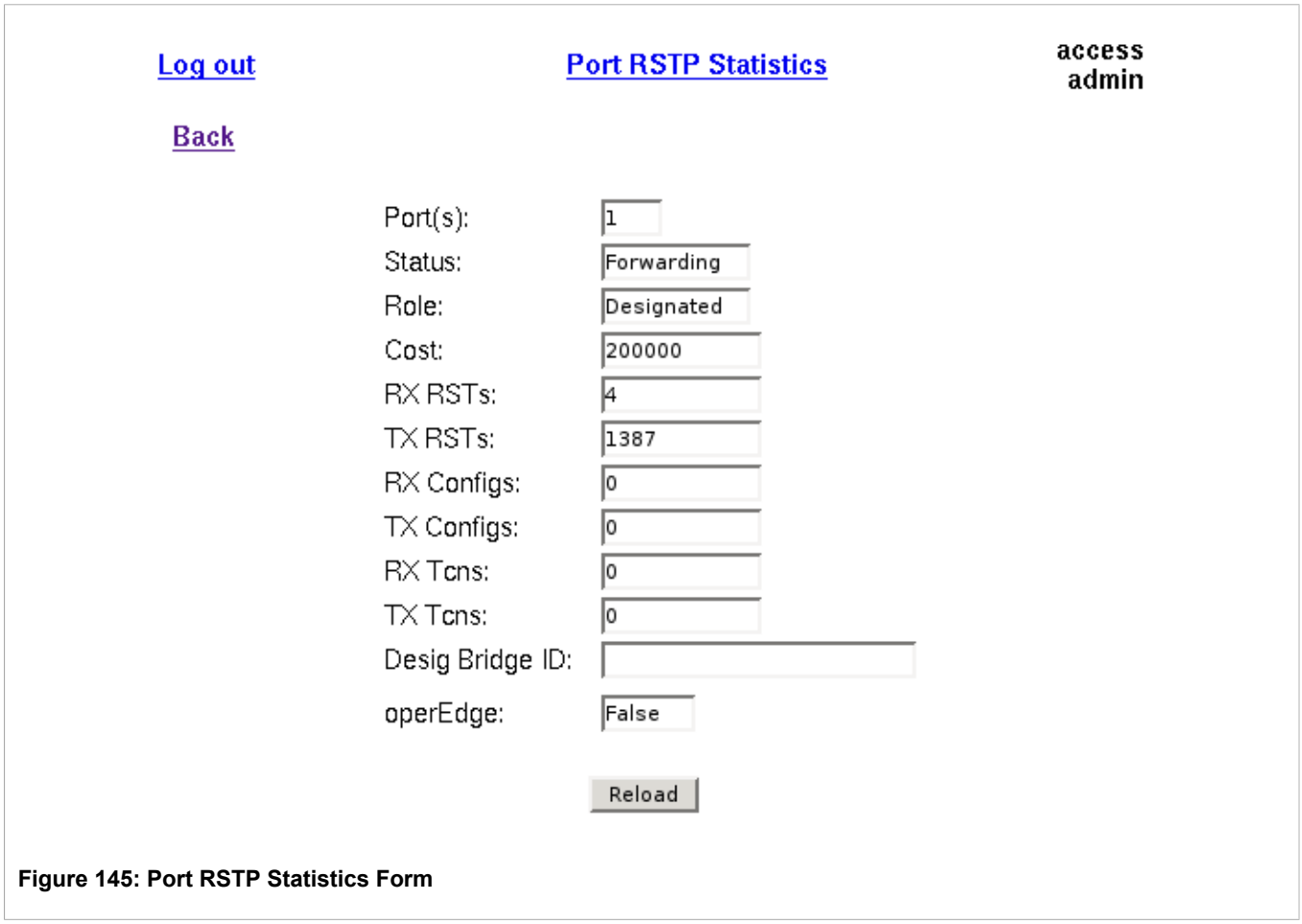


Figure 145: Port RSTP Statistics Form

Parameter	Description
Port(s)	**Synopsis:** Any combination of numbers valid for this parameter

Parameter	Description
	The port number as seen on the front plate silkscreen of the switch (or a list of ports, if aggregated in a port trunk).
Status	**Synopsis:** { Disabled, Listening, Learning, Forwarding, Blocking, Link Down, Discarding } The status of this port in the Spanning Tree. This may be one of the following: Disabled - STP is disabled on this port. Link Down - STP is enabled on this port but the link is down. Discarding - The link is not used in the STP topology but is standing by. Learning - The port is learning MAC addresses in order to prevent flooding when it begins forwarding traffic. Forwarding - The port is forwarding traffic.
Role	**Synopsis:** { <empty string>, Root, Designated, Alternate, Backup, Master } The role of this port in the Spanning Tree. This may be one of the following: Designated - The port is designated for (i.e. carries traffic towards the root for) the LAN it is connected to. Root - The single port on the bridge, which provides connectivity towards the root bridge. Backup - The port is attached to a LAN that is serviced by another port on the bridge. It is not used but is standing by. Alternate - The port is attached to a bridge that provides connectivity to the root bridge. It is not used but is standing by.
Cost	**Synopsis:** 0 to 4294967295 Cost offered by this port. If the Bridge RSTP Parameters Cost Style is set to STP, 1Gbps ports will contribute a cost of four, 100 Mbps ports will contribute 19 and 10 Mbps ports contribute 100. If the Cost Style is set to RSTP, 1Gbps will contribute 20,000, 100 Mbps ports will contribute a cost of 200,000 and 10 Mbps ports contribute a cost of 2,000,000. Note that even if the Cost Style is set to RSTP, a port that migrates to STP will have its cost limited to a maximum of 65535.
RX RSTs	**Synopsis:** 0 to 4294967295 The count of RSTP configuration messages received on this port.
TX RSTs	**Synopsis:** 0 to 4294967295 The count of RSTP configuration messages transmitted on this port.
RX Configs	**Synopsis:** 0 to 4294967295 The count of STP configuration messages received on this port.
TX Configs	**Synopsis:** 0 to 4294967295 The count of STP configuration messages transmitted on this port.
RX Tcns	**Synopsis:** 0 to 4294967295 The count of configuration change notification messages received on this port. Excessively high or rapidly increasing counts signal network problems.
TX Tcns	**Synopsis:** 0 to 4294967295 The count of configuration messages transmitted from this port.
Desig Bridge ID	**Synopsis:** $$ / ##-##-##-##-##-## where $$ is 0 to 65535, ## is 0 to FF Provided on the root ports of designated bridges, the Bridge Identifier of the bridge this port is connected to.
operEdge	**Synopsis:** { True or False } Whether or not the port is operating as an edge port.

Section 7.5.3

Bridge MSTI Statistics

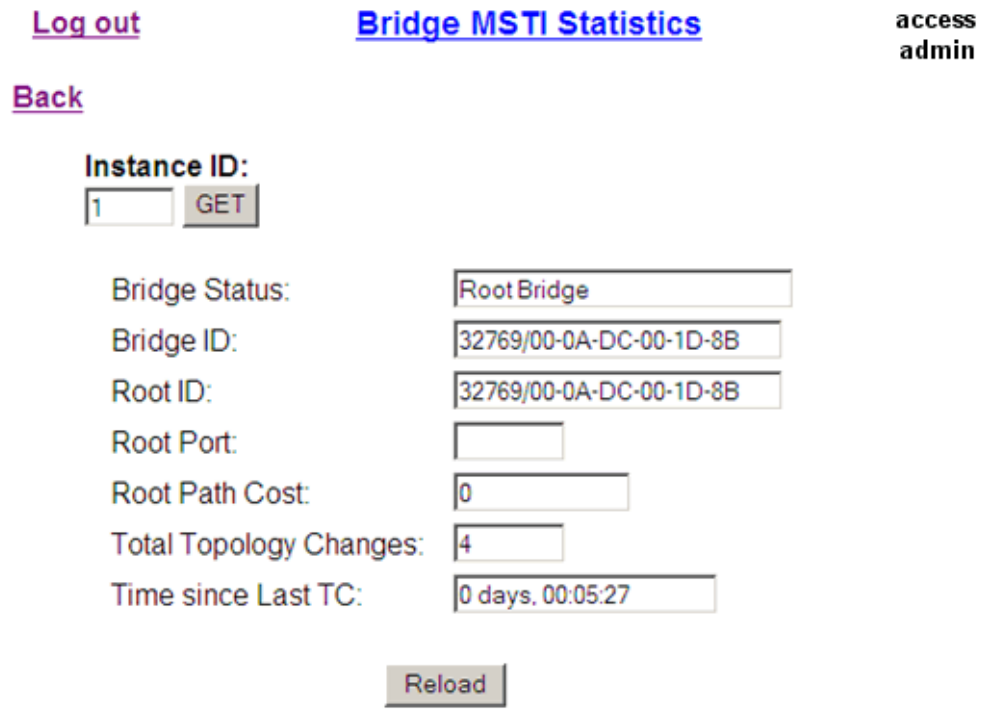


Figure 146: Bridge MSTI Statistics Form

Parameter	Description
Instance ID	**Synopsis:** 0 to 16 **Default:** 1 The Instance ID refers to the MSTI (Multiple Spanning Tree Instance) ID. Specify an Instance ID and select GET in order to load parameters corresponding to the selected MSTI. Note: Bridge Statistics for the IST (MSTI zero), are accessible via the Bridge RSTP Statistics menu (see Section 7.5.1, “Bridge RSTP Statistics”).
Bridge Status	**Synopsis:** { <empty string>, Designated Bridge, Not Designated For Any LAN, Root Bridge } Spanning Tree status of the bridge. The status may be root or designated. This field may display "Not designated For Any LAN" if the bridge is not the designated bridge for any of its ports.
Bridge ID	**Synopsis:** $$ / ##-##-##-##-##-## where $$ is 0 to 65535, ## is 0 to FF Bridge Identifier of this bridge.
Root ID	**Synopsis:** $$ / ##-##-##-##-##-## where $$ is 0 to 65535, ## is 0 to FF Bridge Identifier of the root bridge.
Root Port	**Synopsis:** 0 to 65535 or { <empty string>} If the bridge is designated, this is the port that provides connectivity towards the root bridge of the network.
Root Path Cost	**Synopsis:** 0 to 4294967295

Parameter	Description
	The total cost of the path to the root bridge composed of the sum of the costs of each link in the path. If custom costs have not been configured. 1Gbps ports will contribute a cost of four, 100 Mbps ports will contribute 19 and 10 Mbps ports will contribute 100 to this figure. For the CIST instance of MSTP, this is an external root path cost, which is the cost of the path from the IST root (i.e. regional root) bridge to the CST root (i.e. network "global" root) bridge.
Total Topology Changes	**Synopsis:** 0 to 65535 A count of topology changes in the network, as detected on this bridge through link failures or as signaled from other bridges. Excessively high or rapidly increasing counts signal network problems.
Time since Last TC	**Synopsis:** D days, HH:MM:SS Displays the time since the last topology change on the specific MSTI instance.

Section 7.5.4
Port MSTI Statistics

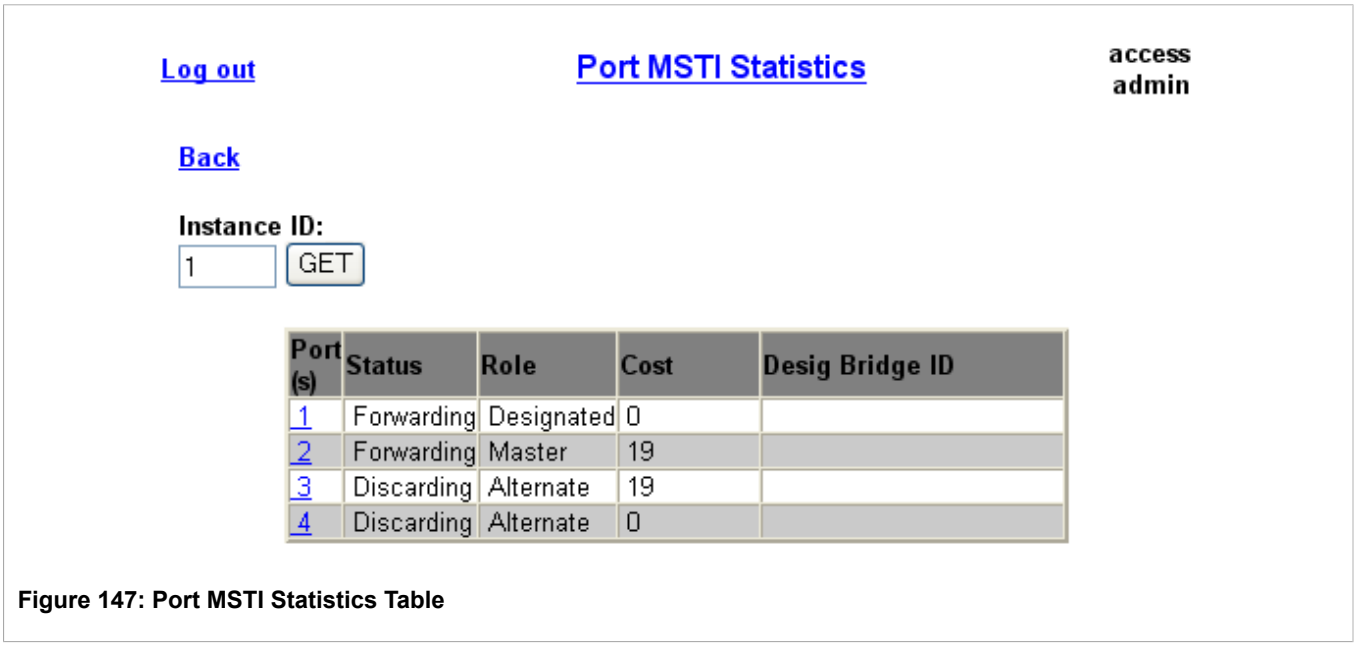


Figure 147: Port MSTI Statistics Table

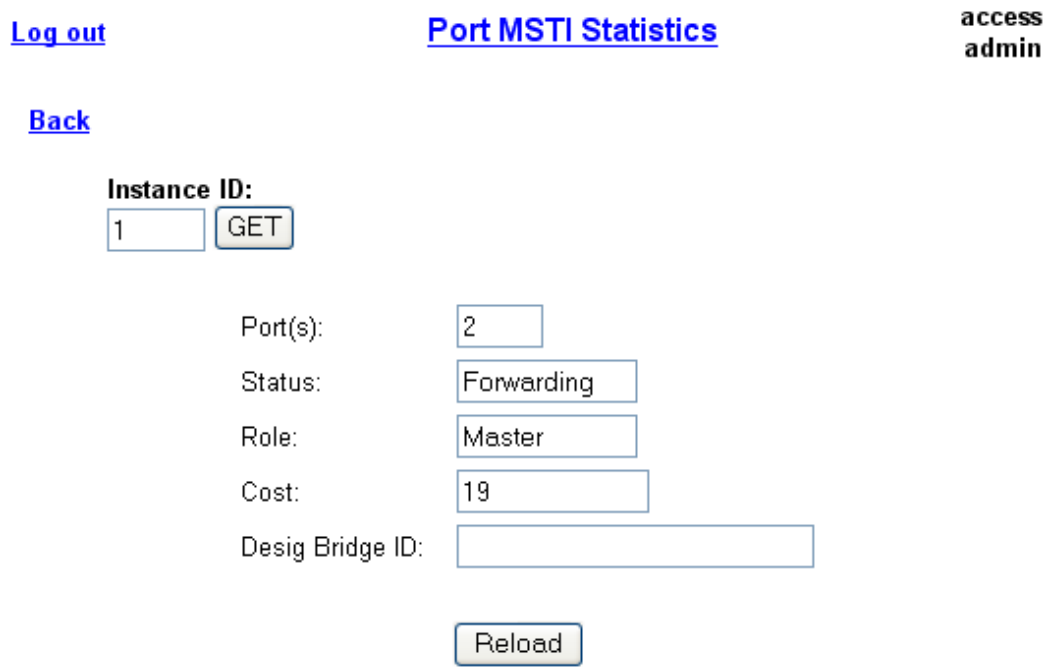


Figure 148: Port MSTI Statistics Form

Parameter	Description
Instance ID	**Synopsis:** 1 to 16 **Default:** 1 The Instance ID refers to the MSTI (Multiple Spanning Tree Instance) ID. Specify an Instance ID and select GET in order to load parameters corresponding to the selected MSTI. Note: Port Statistics for the IST (MSTI zero), are accessible via the Port RSTP Statistics menu (see Section 7.5.2, "Port RSTP Statistics").
Port(s)	**Synopsis:** Any combination of numbers valid for this parameter The port number as seen on the front plate silkscreen of the switch (or a list of ports, if aggregated in a port trunk).
Status	**Synopsis:** { Disabled, Listening, Learning, Forwarding, Blocking, Link Down, Discarding } The status of this port in the Spanning Tree. This may be one of the following: Disabled - STP is disabled on this port. Link Down - STP is enabled on this port but the link is down. Discarding - The link is not used in the STP topology but is standing by. Learning - The port is learning MAC addresses in order to prevent flooding when it begins forwarding traffic. Forwarding - The port is forwarding traffic.
Role	**Synopsis:** { <empty string>, Root, Designated, Alternate, Backup, Master } The role of this port in the Spanning Tree. This may be one of the following: Designated - The port is designated for (i.e. carries traffic towards the root for) the LAN it is connected to. Root - The single port on the bridge, which provides connectivity towards the root bridge. Backup - The port is attached to a LAN that is serviced by another port on the bridge. It is not used but is standing by.

Parameter	Description
	Alternate - The port is attached to a bridge that provides connectivity to the root bridge. It is not used but is standing by. Master - Only exists in MSTP. The port is an MST region boundary port and the single port on the bridge, which provides connectivity for the Multiple Spanning Tree Instance towards the Common Spanning Tree root bridge (i.e. this port is the root port for the Common Spanning Tree Instance).
Cost	**Synopsis:** 0 to 4294967295 Cost offered by this port. If the Bridge RSTP Parameters Cost Style is set to STP, 1Gbps ports will contribute a cost of four, 100 Mbps ports will contribute 19 and 10 Mbps ports contribute. If the Cost Style is set to RSTP, 1Gbps will contribute 20,000, 100 Mbps ports will contribute a cost of 200,000 and 10 Mbps ports contribute a cost of 2,000,000. Note that even if the Cost Style is set to RSTP, a port that migrates to STP will have its cost limited to a maximum of 65535.
Desig Bridge ID	**Synopsis:** $$ / ##-##-##-##-##-## where $$ is 0 to 65535, ## is 0 to FF Provided on the root ports of designated bridges, the Bridge Identifier of the bridge this port is connected to.

Section 7.5.5
Clear STP Statistics

Clicking the *Clear Spanning Tree Statistics* link on the main Spanning Tree menu (see Figure 134, "Spanning Tree Menu") presents the following confirmation form:

Figure 149: Clear Spanning Tree Statistics Confirmation Form

Click the *Confirm* button to clear all statistics maintained by ROS for spanning tree, including global and port-based statistics.

Section 7.6
Troubleshooting

Problem One

When I connect a new port the network locks up. The port status LEDs are flashing madly.

Occasionally, the network seems to experience a lot of flooding. All the ports seem to experience significant traffic. The problem lasts a few seconds and then goes away.

One of my switches displays a strange behavior where the root port hops back and forth between two switch ports and never settles down.

Is it possible that one of the switches in the network or one of the ports on a switch in the network has STP disabled and accidentally connects to another switch? If this has occurred, then a traffic loop has been formed.

If the problem appears to be transient in nature, it is possible that ports that are part of the spanning tree have been configured as edge ports. After the link layers have come up on edge ports, STP will directly transition them (perhaps improperly) to the forwarding state. If an RSTP configuration message is then received, the port will be returned to blocking. A traffic loop may be formed for the length of time the port was in forwarding.

If one of the switches appears to flip the root from one port to another, the problem may be one of traffic prioritization (See problem five).

Another possible cause of intermittent operation is that of an auto-negotiation mismatch. If one end of the link is fixed to full-duplex mode and the peer auto-negotiates, the auto-negotiating end will fall back to half-duplex operation. At lower traffic, the volumes the link may display few if any errors. As the traffic volume rises, the fixed negotiation side will begin to experience dropped packets while the auto-negotiating side will experience collisions. Ultimately, as traffic loads approach 100%, the link will become entirely unusable. At this point, RSTP will not be able to transmit configuration messages over the link and the spanning tree topology will break down. If an alternate trunk exists, RSTP will activate it in the place of the congested port. Since activation of the alternate port often relieves the congested port of its traffic, the congested port will once again become reliable. RSTP will promptly enter it back into service, beginning the cycle once again. The root port will flip back and forth between two ports on the switch.

Problem Two

My PC/IED/Device is connected to your switch. After I reset the switch, it takes a long time before it comes up.

Is it possible that the RSTP edge setting for this port is set to false? If Edge is set to false, the bridge will make the port go through two forward delay times before the port can send or receive frames. If Edge is set to true, the bridge will transition the port directly to forwarding upon link up.

Another possible explanation is that some links in the network run in half-duplex mode. RSTP uses a peer-to-peer protocol called Proposal-Agreement to ensure transitioning in the event of a link failure. This protocol requires full-duplex operation. When RSTP detects a non-full duplex port, it cannot rely on Proposal-Agreement protocol and must make the port transition the slow (i.e. STP) way. If possible, configure the port for full-duplex operation. Otherwise, configure the port's point-to-point setting to true. Either one will allow the Proposal-Agreement protocol to be used.

Problem Three

When I test your switch by deliberately breaking a link, it takes a long time before I can poll devices past the switch. I thought RSTP was supposed to be fast. What is happening?

Is it possible that some ports participating in the topology have been configured to STP mode or that the port's point-to-point parameter is set to false? STP and multipoint ports converge slowly after failures occur.

Is it possible that the port has migrated to STP? If the port is connected to the LAN segment by shared media and STP bridges are connected to that media, then convergence after link failure will be slow.

Delays on the order of tens or hundreds of milliseconds can result in circumstances where the link broken is the sole link to the root bridge and the secondary root bridge is poorly chosen. The worst of all possible designs occurs when the secondary root bridge is located at the farthest edge of the network from the root. In this case, a configuration message will have to propagate out to the edge and then back in order to reestablish the topology.

Problem Four

My network is composed of a ring of bridges, of which two (connected to each other) are managed and the rest are unmanaged. Why does the RSTP protocol work quickly when I break a link between the managed bridges but not in the unmanaged bridge part of the ring?

A properly operating unmanaged bridge is transparent to STP configuration messages. The managed bridges will exchange configuration messages through the unmanaged bridge part of the ring as if it is non-existent. When a link in the unmanaged part of the ring fails however, the managed bridges will only be able to detect the failure through timing out of hello messages. Full connectivity will require three hello times plus two forwarding times to be restored.

Problem Five

The switch is up and running and working fine. Then I start a certain application and the network becomes unstable. After I stop the application, the network goes back to running normally.

RSTP sends its configuration messages using the highest possible priority level. If CoS is configured to allow traffic flows at the highest priority level and these traffic flows burst continuously to 100% of the line bandwidth, STP may be disrupted. It is therefore advised not to use the highest CoS.

Problem Six

After I bring up a new port, the root moves on to that port, and I don't want it to. The port that I want to become root won't do so.

Is it possible that the port cost is incorrectly programmed or that auto-negotiation derives an undesired value? Inspect the port and path costs with each port active as root.

Problem Seven

My IED/Controller does not work with your switch.

Certain low CPU bandwidth controllers have been found to behave less than perfectly when they receive unexpected traffic. Try disabling STP for the port.

If the controller fails around the time of a link outage then there is the remote possibility that frame disordering or duplication may be the cause of the problem. Try setting the root port of the failing controller's bridge to STP.

Problem Eight

My network runs fine with your switch but I occasionally lose polls to my devices.

Inspect network statistics to determine whether the root bridge is receiving TCNs around the time of observed frame loss. It may be possible that you have problems with intermittent links in your network.

Problem Nine

I'm getting a lot of TCNs at the root, where are they coming from?

Examine the RSTP port statistics to determine the port from which the TCNs are arriving. Sign-on to the switch at the other end of the link attached to that port. Repeat this step until the switch generating the TCNs is found (i.e. the switch that is itself not receiving a large number of TCNs). Determine the problem at that switch.

8 VLANs

ROS provides the following VLAN features:

- Support for up to 255 VLANs
- Configurable port-native VLAN.
- Port modes of operation tailored to edge devices (such as a PC or IED) and to network switch interconnections.
- A default setting that ensures configuration-free connectivity in certain scenarios.
- Ability to force either tagged or untagged operation on the port-native VLAN.
- Ability to switch between VLAN-aware and VLAN-unaware modes of operation.
- GARP VLAN Registration Protocol (GVRP).
- Double VLAN-tagging, or QinQ
- Configurable management VLAN

Section 8.1
VLAN Operation

Section 8.1.1
VLANs and Tags

A virtual LAN or VLAN is a group of devices on one or more LAN segments that communicate as if they were attached to the same physical LAN segment. VLANs are extremely flexible because they are based on logical instead of physical connections.

When VLANs are introduced, all traffic in the network must belong to one or another VLAN. Traffic on one VLAN cannot pass to another, except through an internetwork router or Layer 3 switch.

A VLAN tag is the identification information that is present in frames in order to support VLAN operation.

Section 8.1.2
Tagged vs. Untagged Frames

Tagged frames are frames with 802.1Q (VLAN) tags that specify a valid VLAN identifier (VID). Untagged frames are frames without tags or frames that carry 802.1p (prioritization) tags only having prioritization information and a VID of 0. Frames with a VID=0 are also called priority-tagged frames.

When a switch receives a tagged frame, it extracts the VID and forwards the frame to other ports in the same VLAN.

Section 8.1.3
Native VLAN

Each port is assigned a native VLAN number, the Port VLAN ID (PVID). When an untagged frame ingresses a port, it is associated with the port's native VLAN.

By default, when the switch transmits a frame on the native VLAN, it sends the frame untagged. The switch can be configured to transmit frames on the native VLAN tagged.

Section 8.1.4
Management VLAN

Management traffic, like all traffic on the network, must belong to a specific VLAN. The management VLAN is configurable and always defaults to VLAN 1. This VLAN is also the default native VLAN for all ports, thus allowing all ports the possibility of managing the product. Changing the management VLAN can be used to restrict management access to a specific set of users.

Section 8.1.5
Edge and Trunk Port Types

Each port can be configured to take on a type of Edge or Trunk.

Edge Type
An Edge port attaches to a single end device (such as a PC or IED) and carries traffic on a single pre-configured VLAN, the native VLAN.

Trunk Type
Trunk ports are part of the network and carry traffic for all VLANs between switches.

Trunk ports are automatically members of all VLANs configured in the switch.

The switch can "pass through" traffic, forwarding frames received on one trunk port out another trunk port. The trunk ports must be members of all the VLANs the "pass through" traffic is part of, even if none of those VLANs are used on edge ports.

Frames transmitted out of the port on all VLANs other than the port's native VLAN are always sent tagged.

NOTE
Sometimes it may be desirable to manually restrict the traffic on the trunk to a certain group of VLANs. For example, when the trunk connects to a device (such as a Layer 3 router) that supports a subset of the available VLANs. The trunk port can be prevented from being a member of the VLAN by including it in the VLAN's Forbidden Ports list.

Port Type	VLANs Supported	PVID Format	Usage
Edge	1 (Native) Configured	Untagged	*VLAN Unaware networks* – All frames are sent and received without the need for VLAN tags.
		Tagged	*VLAN Aware networks* – VLAN traffic domains are enforced on a single VLAN.

Port Type	VLANs Supported	PVID Format	Usage
Trunk	All Configured	Tagged or Untagged	*Switch-to-Switch connections* – VLANs must be manually created and administered or can be dynamically learned through GVRP. *Multiple-VLAN end devices* – Implement connections to end devices that support multiple VLANs at the same time.

Section 8.1.6
VLAN Ingress and Egress Rules

Ingress Rules

These are the VLAN ingress rules, i.e. the rules applied to all frames when they are received by the switch:

Frame received This does not depend on ingress port's VLAN configuration parameters	Untagged	Priority Tagged (VID=0)	Tagged >(valid VID)
VLAN ID associated with the frame	PVID	PVID	VID in the tag
Frame dropped due to its tagged/untagged format	No	No	No
Frame dropped, if VLAN associated with the frame is not configured (or learned) in the switch	N/A	N/A	Yes
Frame dropped, if ingress port is not a member of the VLAN the frame is associated with	N/A	N/A	No

Egress Rules

These are the VLAN egress rules, i.e. the rules applied to all frames when they are transmitted by the switch:

Frame sent Egress port type	On egress port's native VLAN	On other VLAN	
		Port is a member of the VLAN	Port is not a member of the VLAN
Edge	According to the egress port's "PVID Format" parameter	N/A (frame is dropped)	
Trunk		Tagged	dropped

Section 8.1.7
Forbidden Ports List

Each VLAN can be configured to exclude ports from membership in the VLAN.

Section 8.1.8
VLAN-aware And VLAN-unaware Modes Of Operation

The native operation mode for an IEEE 802.1Q compliant switch is VLAN-aware. Even if a specific network architecture does not use VLANs, ROS default VLAN settings allow the switch still to operate in a VLAN-aware

mode while providing functionality required for almost any network application. However, the IEEE 802.1Q standard defines a set of rules that must be followed by all VLAN-aware switches, for example:

- Valid VID range is 1 to 4094 (VID=0 and VID=4095 are invalid).
- Each frame ingressing a VLAN-aware switch is associated with a valid VID.
- Each frame egressing a VLAN-aware switch is either untagged or tagged with a valid VID (this means priority-tagged frames with VID=0 are never sent out by a VLAN-aware switch).

It turns out that some applications have requirements conflicting with the IEEE 802.1Q native mode of operation (e.g. some applications explicitly require priority-tagged frames to be received by end devices).

To ensure the required operation in any possible application scenario and provide full compatibility with legacy (VLAN-unaware) devices, the device can be configured to work in a VLAN-unaware mode.

In that mode:

- Frames ingressing a VLAN-unaware switch are not associated with any VLAN.
- Frames egressing a VLAN-unaware switch are sent out unmodified, i.e. in the same untagged, 802.1Q-tagged or priority-tagged format as they were received.

Section 8.1.9

GVRP (GARP VLAN Registration Protocol)

GVRP is a standard protocol built on GARP (the Generic Attribute Registration Protocol) to automatically distribute VLAN configuration information in a network. Each switch in a network needs only to be configured with VLANs it requires locally; it dynamically learns the rest of the VLANs configured elsewhere in the network via GVRP. A GVRP-aware end station, configured for a particular VLAN ID, can be connected to a trunk on a GVRP-aware switch and automatically become part of the desired VLAN.

When a switch sends GVRP BPDUs out of all GVRP-enabled ports, GVRP BPDUs advertise all the VLANs known to that switch (configured anually or learned dynamically through GVRP) to the rest of the network.

When a GVRP-enabled switch receives a GVRP BPDU advertising a set of VLANs, the receiving port becomes a member of those advertised VLANs and the switch begins advertising those VLANs via all the GVRP-enabled ports (other than the port on which the VLANs were learned).

To improve network security using VLANs, GVRP-enabled ports may be configured to prohibit the learning of any new dynamic VLANs but at the same time be allowed to advertise the VLANs configured on the switch.

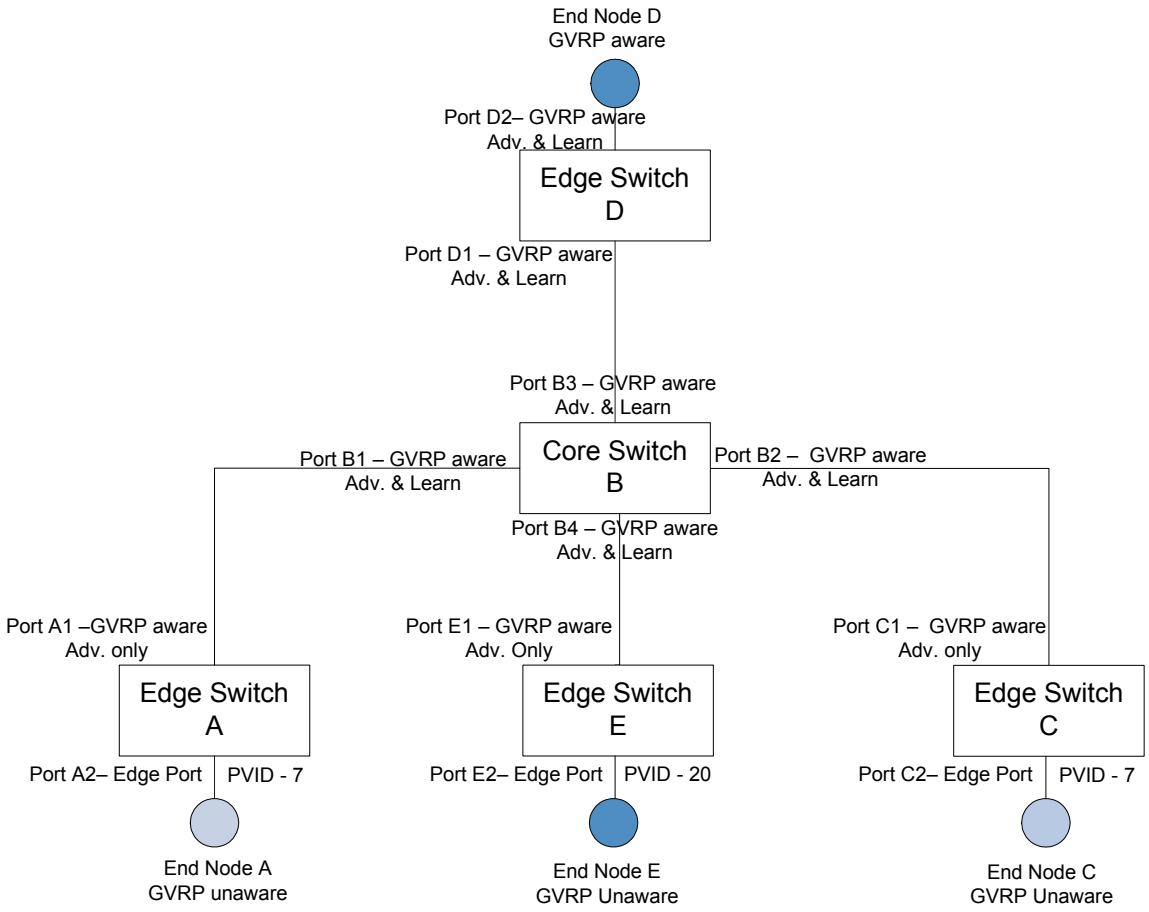


Figure 150: Using GVRP

An example of using GVRP:

- Ports A2, and C2 are configured with PVID 7 and port E2 is configured with PVID 20.
- End Node D is GVRP aware and is interested in VLAN 20, hence VLAN 20 is advertised by it towards switch D.
- D2 becomes member of VLAN 20.
- Ports A1 and C1 advertise VID 7 and ports B1 and B2 become members of VLAN 7.
- Ports D1 and B1 advertise VID 20 and ports B3, B4 and D1 become members of VLAN 20.

Section 8.1.10

PVLAN Edge

PVLAN Edge (Protected VLAN Edge port) refers to a feature of the switch whereby multiple VLAN Edge ports on a single device are effectively isolated from one another. All VLAN Edge ports in a switch that are configured as "protected" in this way are prohibited from sending frames to each other, but are still allowed to send frames to other, non-protected, ports within the same VLAN. This protection extends to all traffic on the VLAN: unicast, multicast, or broadcast.

Note that this feature is strictly local to the switch. PVLAN Edge ports are not prevented from communicating with ports off the switch, whether protected (remotely) or not.

Section 8.1.11
QinQ

QinQ is also known as double VLAN-tagging or as Nested VLANs. It is used to overlay a private Layer 2 network over a public Layer 2 network.

A large network service provider, for example, might have several clients whose networks each use multiple VLANs. It is likely that the VLAN IDs used by these different client networks would conflict with one another, were they mixed together in the provider's network. Using double VLAN-tagging, each client network could be further tagged using a client-specific VID at the edges where the clients' networks are connected to the network service provider's infrastructure.

Frames ingressing an edge port of the service provider switch are tagged with VIDs of the customer's private network. When those frames egress the switch's QinQ-enabled port into the service provider network the switch always adds an extra tag (called outer tag) on top of the frames' original VLAN tag (called inner tag) and the outer tag VID is the PVID of the frames' ingress edge port. This means that traffic from an individual customer is tagged with his unique VID and is thus segregated from other customers' traffic.

Within the service provider network, switching is based on the VID in the outer tag.

When double-tagged frames leave the service provider network, they egress a QinQ-enabled port of another switch. The switch strips the outer tag while associating the frames with the VID extracted from it before stripping. Thus, the frames are switched to appropriate edge ports, i.e. to appropriate customers.

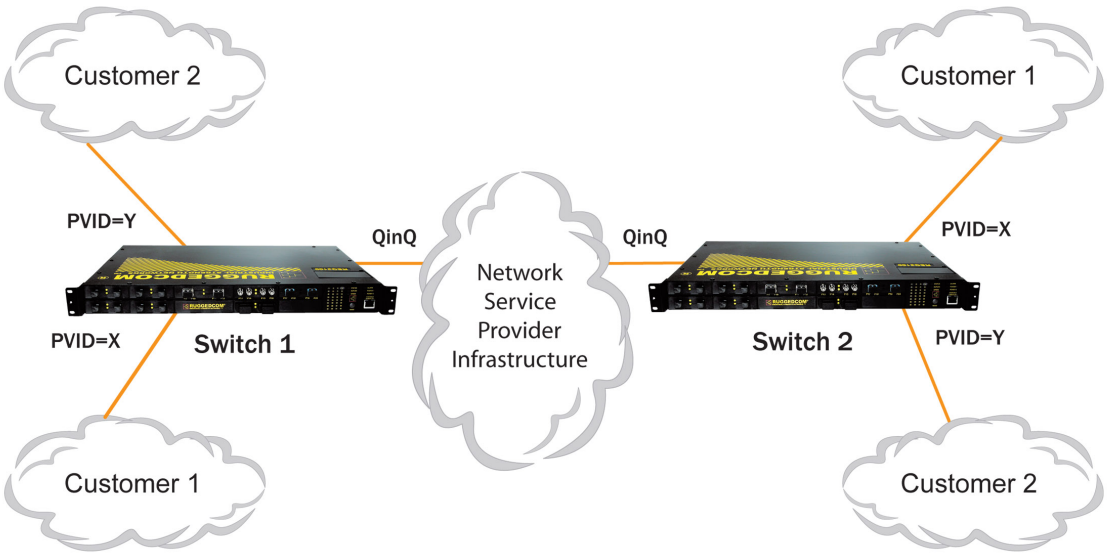


Figure 151: Using QinQ Example

NOTE
QinQ can only be enabled on one switch port at a time.

NOTE
Some switch models only support QinQ if all edge ports are configured with the same PVID. In this case, a dedicated switch must be assigned to each customer.

Section 8.2
VLAN Applications

Section 8.2.1
Traffic Domain Isolation

VLANs are most often used for their ability to restrict traffic flows between groups of devices.

Unnecessary broadcast traffic can be restricted to the VLAN that requires it. Broadcast storms in one VLAN need not affect users in other VLANs.

Hosts on one VLAN can be prevented from accidentally or deliberately assuming the IP address of a host on another VLAN.

By configuring the management VLAN, a management domain can be established that restricts the number of users able to modify the configuration of the network.

The use of creative bridge filtering and multiple VLANs can carve seemingly unified IP subnets into multiple regions policed by different security/access policies.

Multi-VLAN hosts can assign different traffic types to different VLANs.

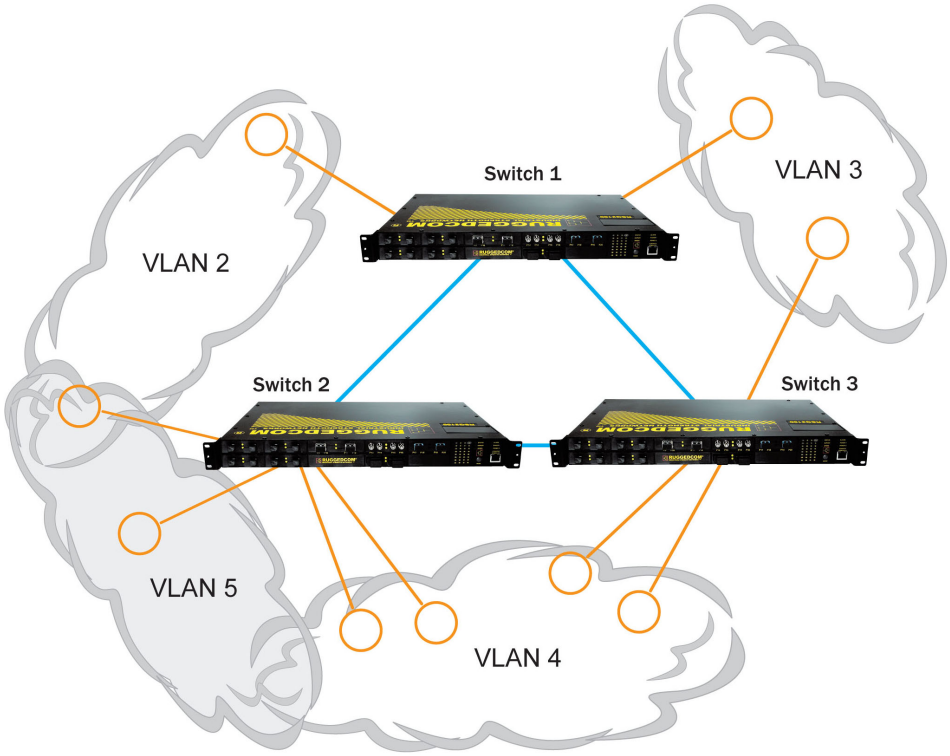


Figure 152: Multiple Overlapping VLANs

Section 8.2.2
Administrative Convenience

VLANs enable equipment moves to be handled by software reconfiguration instead of by physical cable management. When a host's physical location is changed, its connection point is often changed as well. With VLANs, the host's VLAN membership and priority are simply copied to the new port.

Section 8.2.3
Reduced Hardware

Without VLANs, traffic domain isolation requires using separate bridges for separate networks. VLANs eliminate the need for separate bridges.

The number of network hosts may often be reduced. Often, a server is assigned to provide services for independent networks. These hosts may be replaced by a single, multi-homed host supporting each network on its own VLAN. This host can perform routing between VLANs.

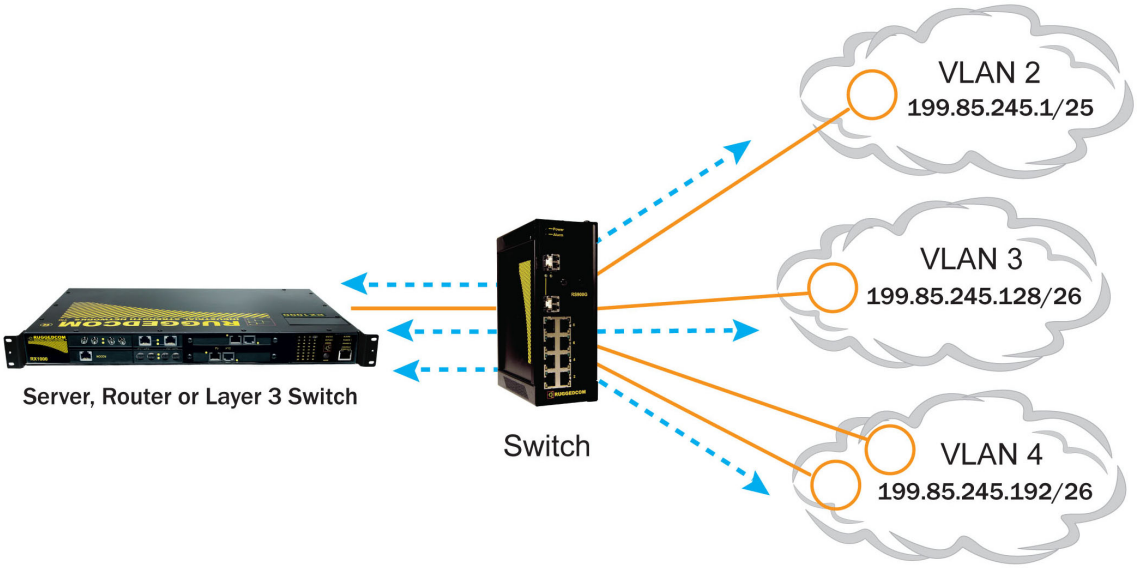


Figure 153: Inter-VLAN Communications

Section 8.3

VLAN Configuration

The Virtual LANs menu is accessible from the main menu.

Figure 154: Virtual LANs Menu

Section 8.3.1
Global VLAN Parameters

Figure 155: Global VLAN Parameters Form

Parameter	Description
VLAN-aware	**Synopsis:** { No, Yes } **Default:** Yes Set either VLAN-aware or VLAN-unaware mode of operation.

NOTE
Do not attempt to change the "VLAN-aware" parameter of the managed switch by applying a configuration (.CSV) file update. Configuration file updates are used to apply "bulk changes" to the current configuration of a switch. Instead, a change to this individual parameter MUST first be applied separately from any other table (i.e. parameter) changes. In other words, configuration file updates should exclude the "VLAN-aware" parameter.

Section 8.3.2
Static VLANs

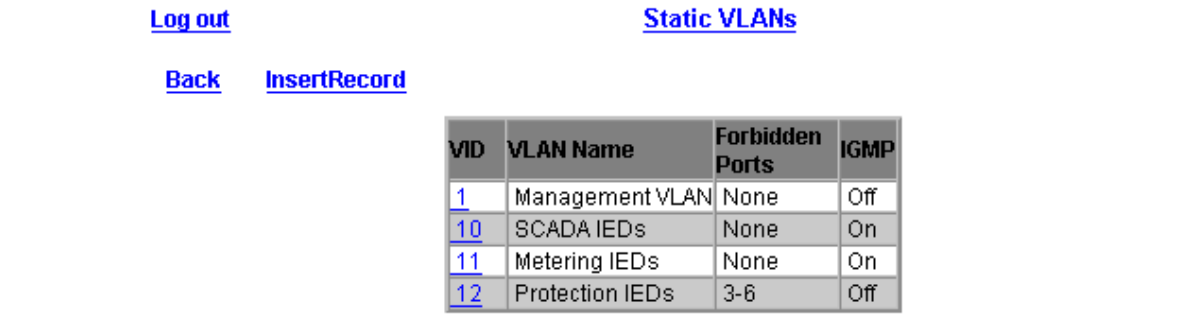


Figure 156: Static VLANs Table

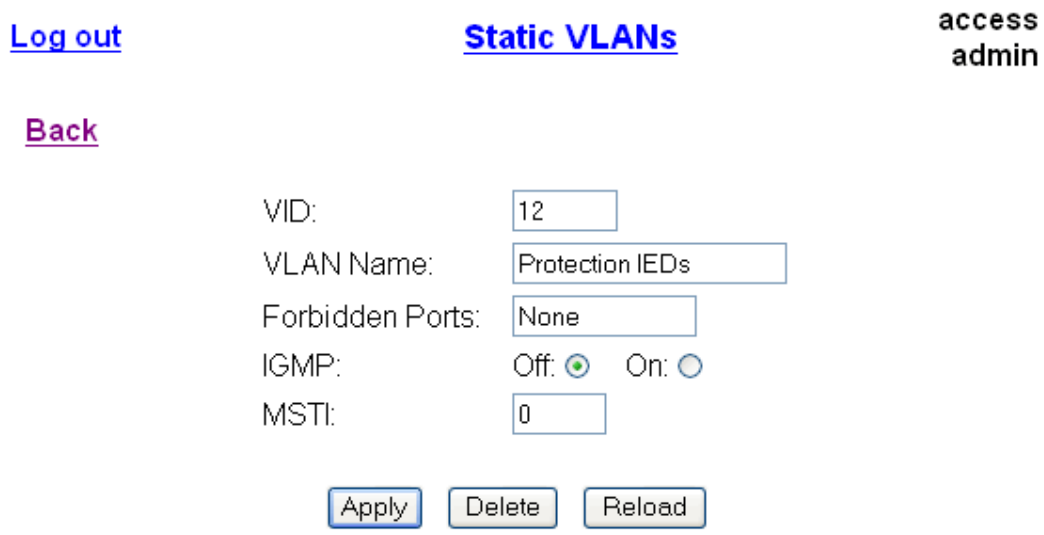


Figure 157: Static VLANs Form

Parameter	Description
VID	**Synopsis:** 1 to 4094 **Default:** 1 The VLAN Identifier is used to identify the VLAN in tagged Ethernet frames according to IEEE 802.1Q.
VLAN Name	**Synopsis:** Any 19 characters Default: The VLAN name provides a description of the VLAN purpose (for example, Engineering VLAN).
Forbidden Ports	**Synopsis:** Any combination of numbers valid for this parameter **Default:** None These are ports that are not allowed to be members of the VLAN. Examples: None - all ports of the switch are allowed to be members of the VLAN 2,4-6,8 - all ports except ports 2,4,5,6 and 8 are allowed to be members of the VLAN
IGMP	**Synopsis:** { Off, On } **Default:** Off This parameter enables or disables IGMP Snooping on the VLAN.
MSTI	**Synopsis:** 0 to 16 **Default:** 0 This parameter is only valid for Multiple Spanning Tree Protocol (MSTP) and has no effect, if MSTP is not used. The parameter specifies the Multiple Spanning Tree Instance (MSTI) to which the VLAN should be mapped.

NOTE
If IGMP Snooping is not enabled for the VLAN, both IGMP messages and multicast streams will be forwarded directly to all members of the VLAN. If any one member of the VLAN joins a multicast group then all members of the VLAN will receive the multicast traffic.

Section 8.3.3

Port VLAN Parameters

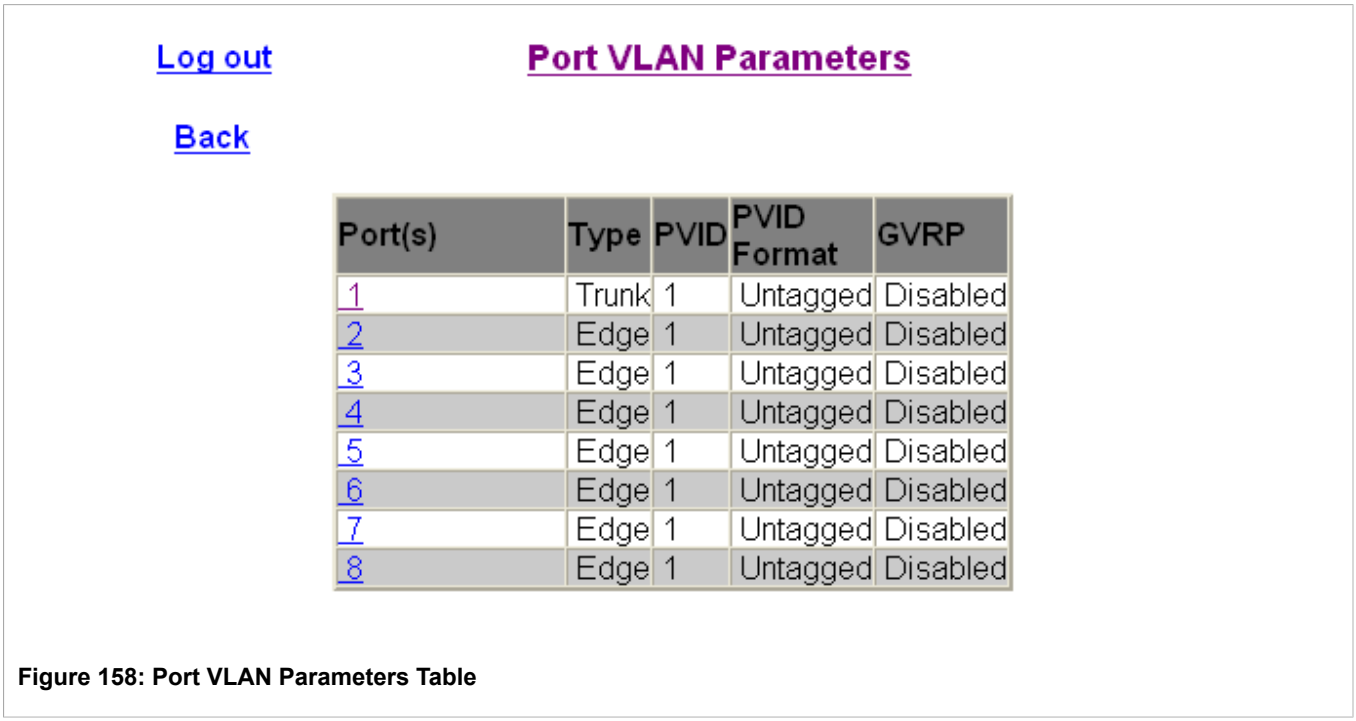

Log out
Port VLAN Parameters
Back
Port(s) Type PVID PVID Format GVRP
1 Trunk 1 Untagged Disabled
2 Edge 1 Untagged Disabled
3 Edge 1 Untagged Disabled
4 Edge 1 Untagged Disabled
5 Edge 1 Untagged Disabled
6 Edge 1 Untagged Disabled
7 Edge 1 Untagged Disabled
8 Edge 1 Untagged Disabled

Figure 158: Port VLAN Parameters Table

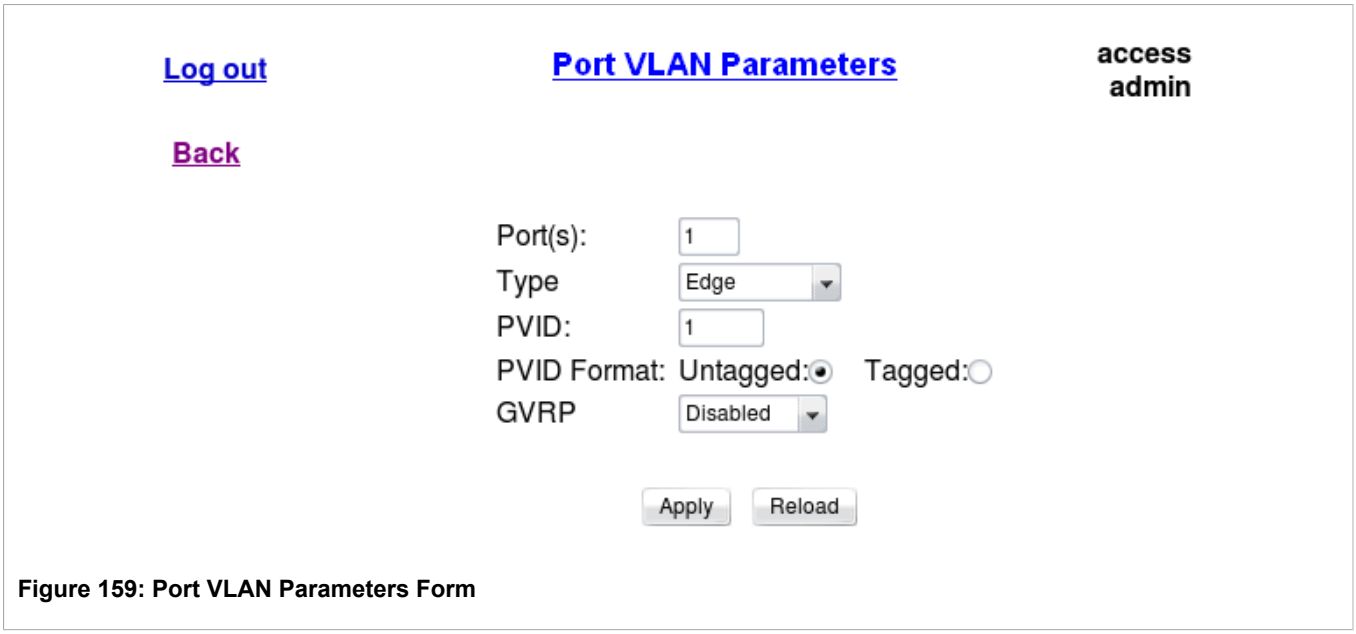


Figure 159: Port VLAN Parameters Form

Parameter	Description
Port(s)	**Synopsis:** Any combination of numbers valid for this parameter The port number as seen on the front plate silkscreen of the switch (or a list of ports, if aggregated in a port trunk).
Type	Synopsis: {Edge, Trunk, PVLANEdge, QinQ} **Default:** Edge

Parameter	Description
	This parameter specifies how the port determines its membership in VLANs. There are few types of ports: Edge - the port is only a member of one VLAN (its native VLAN specified by the 'PVID' parameter). Trunk - the port is automatically a member of all configured VLANs. Frames transmitted out of the port on all VLANs except the port's native VLAN will be always tagged. It can also be configured to use GVRP for automatic VLAN configuration. PVLANEdge - the port is only a member of one VLAN (its native VLAN specified by the 'PVID' parameter), and does not forward traffic to other PVLANedge ports within the same VLAN. QinQ - the port is a trunk port using double-VLAN tagging, or nested VLANs. An extra VLAN tag is always added to all frames egressing this port. VID in the added extra tag is the PVID of the frame's ingress port. VLAN tag is always stripped from frames ingressing this port.
PVID	Synopsis: 1 to 4094 **Default:** 1 The Port VLAN Identifier specifies the VLAN ID associated with untagged (and 802.1p priority tagged) frames received on this port. Frames tagged with a non-zero VLAN ID will always be associated with the VLAN ID retrieved from the frame tag. Modify this parameter with care! By default, the switch is programmed to use VLAN 1 for management and every port on the switch is programmed to use VLAN 1. If you modify a switch port to use a VLAN other than the management VLAN, devices on that port will not be able to manage the switch.
PVID Format	**Synopsis:** { Untagged, Tagged } **Default:** Untagged Specifies whether frames transmitted out of the port on its native VLAN (specified by the 'PVID' parameter) will be tagged or untagged.
GVRP	**Synopsis:** { Adv&Learn, Adv Only, Disabled } **Default:** Disabled Configures GVRP (Generic VLAN Registration Protocol) operation on the port. There are several GVRP operation modes: DISABLED - the port is not capable of any GVRP processing. ADVERTISE ONLY - the port will declare all VLANs existing in the switch (configured or learned) but will not learn any VLANs. ADVERTISE & LEARN - the port will declare all VLANs existing in the switch (configured or learned) and can dynamically learn VLANs. Only Trunk ports are GVRP-capable.

Section 8.3.4
VLAN Summary

There are actually three ways that a VLAN can be created in the switch:

Explicit
A VLAN is explicitly configured in the Static VLANs list.

Implicit
A VLAN ID is a parameter required for different feature configurations (e.g. Port VLAN Parameters, Static MAC Addresses, IP Interface Type and ID). When such a parameter is set to some VLAN ID value, appropriate VLAN is automatically created, if it does not yet exist.

Dynamic

A VLAN learned through GVRP.

> **NOTE**
> *Not explicitly created VLAN is always created with IGMP Snooping disabled. If it is desirable for IGMP to be used on that VLAN, it should be created as a Static VLAN with IGMP enabled.*

All VLANs, regardless of the way they were created, are shown in the VLAN Summary.

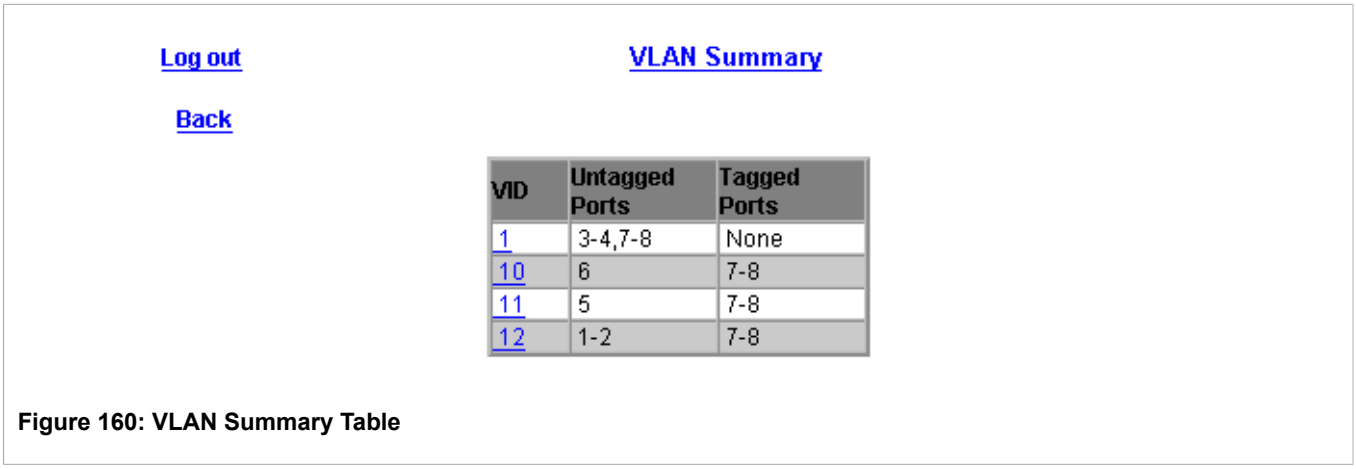


Figure 160: VLAN Summary Table

Parameter	Description
VID	Synopsis: 1 to 4094 The VLAN Identifier is used to identify the VLAN in tagged Ethernet frames according to IEEE 802.1Q.
Untagged Ports	**Synopsis:** Any combination of numbers valid for this parameter All ports that are untagged members of the VLAN.
Tagged Ports	**Synopsis:** Any combination of numbers valid for this parameter All ports that are tagged members of the VLAN.

Section 8.4

Troubleshooting

Problem One

I don't need VLANs at all. How do I turn them off?

Simply leave all ports set to type "Edge" and leave the native VLAN set to 1. This is the default configuration for the switch.

Problem Two

I have added two VLANs: 2 and 3. I made a number of ports members of these VLANS. Now I need some of the devices in one VLAN to send messages to some devices in the other VLAN.

If the devices need to communicate at the physical address layer, they must be members of the same VLAN. If they can communicate in a Layer 3 fashion (i.e. using a protocol such as IP or IPX), you can use a router. The router will treat each VLAN as a separate interface, which will have its own associated IP address space.

Problem Three

I have a network of thirty switches for which I wish to restrict management traffic to a separate domain. What is the best way of doing this while still staying in contact with these switches?

At the switch where the management station is located, configure a port to use the new management VLAN as its native VLAN. Configure a host computer to act as a temporary management station.

At each switch, configure the management VLAN to the new value. As each switch is configured, you will immediately lose contact with it, but should be able to re-establish communications from the temporary management station. After all switches have been taken to the new management VLAN, configure the ports of all attached management devices to use the new VLAN.

NOTE

Establishing a management domain is often accompanied with the establishment of an IP subnet specifically for the managed devices.

9 Port Security

ROS™ Port Security provides you with the following features:

- Authorizing network access using Static MAC Address Table.
- Authorizing network access using IEEE 802.1X authentication.
- Configuring IEEE 802.1X authentication parameters.
- Detecting port security violation attempt and performing appropriate actions.

Section 9.1
Port Security Operation

Port Security, or Port Access Control, provides the ability to filter or accept traffic from specific MAC addresses.

Port Security works by inspecting the source MAC addresses of received frames and validating them against the list of MAC addresses authorized on the port. Unauthorized frames will be filtered and, optionally, the port that receives the frame will be shut down permanently or for a period of time. An alarm will be raised indicating the detected unauthorized MAC address.

Frames to unknown destination addresses will not be flooded through secure ports.

NOTE
Port security is applied at the edge of the network in order to restrict admission to specific devices. Do not apply port security on core switch connections.

ROS supports several MAC address authorization methods.

Section 9.1.1
Static MAC Address-Based Authorization

- With this method, the switch validates the source MAC addresses of received frames against the contents in the Static MAC Address Table.
- ROS also supports a highly flexible Port Security configuration which provides a convenient means for network administrators to use the feature in various network scenarios.
- A Static MAC address can be configured without a port number being explicitly specified. In this case, the configured MAC address will be automatically authorized on the port where it is detected. This allows devices to be connected to any secure port on the switch without requiring any reconfiguration.
- The switch can also be programmed to learn (and, thus, authorize) a preconfigured number of the first source MAC addresses encountered on a secure port. This enables the capture of the appropriate secure addresses when first configuring MAC address-based authorization on a port. Those MAC addresses are automatically inserted into the Static MAC Address Table and remain there until explicitly removed by the user.

Section 9.1.2
IEEE 802.1X Authentication

The IEEE 802.1X standard defines a mechanism for port-based network access control and provides a means of authenticating and authorizing devices attached to LAN ports.

Although 802.1X is mostly used in wireless networks, this method is also implemented in wired switches.

The 802.1X standard defines three major components of the authentication method: Supplicant, Authenticator and Authentication server.

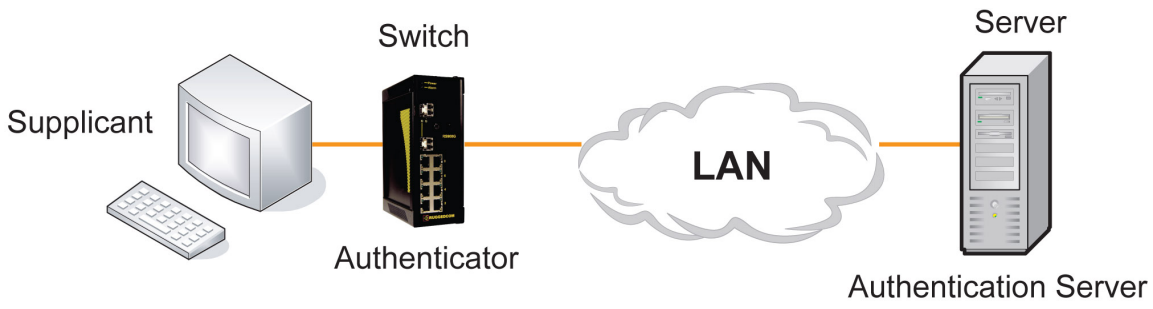


Figure 161: 802.1X General Topology

RUGGEDCOM supports the Authenticator component.

802.1X makes use of Extensible Authentication Protocol (EAP) which is a generic PPP authentication protocol and supports various authentication methods. 802.1X defines a protocol for communication between the Supplicant and the Authenticator, EAP over LAN (EAPOL).

RUGGEDCOM communicates with the Authentication Server using EAP over RADIUS.

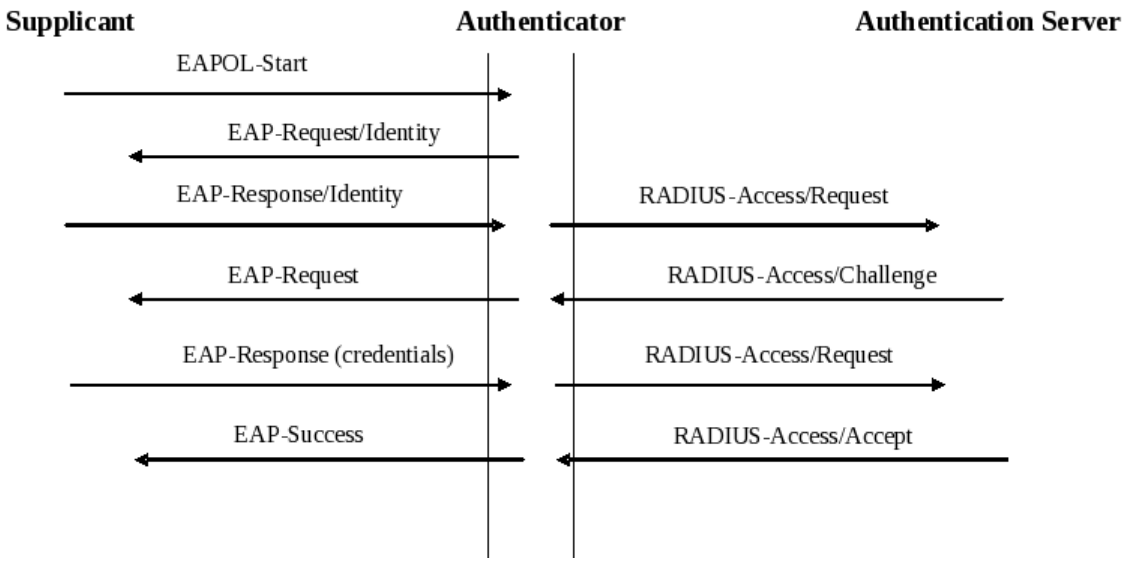


Figure 162: 802.1X Packet Exchange

NOTE
The switch supports authentication of one host per port.

NOTE
If the host's MAC address is configured in the Static MAC Address Table, it will be authorized, even if the host authentication is rejected by the authentication server.

Section 9.1.3
IEEE 802.1X with MAC-Authentication

This method is also known as MAB (MAC-Authentication Bypass). It is commonly used for devices, such as VoIP phones and Ethernet printers, that do not support the 802.1X protocol. This method allows such devices to be authenticated using the same database infrastructure as that used in 802.1X.

IEEE 802.1X with MAC-Authentication Bypass works as follows:

1. The device connects to a switch port.
2. The switch learns the device MAC address upon receiving the first frame from the device (the device usually sends out a DHCP request message when first connected).
3. The switch sends an EAP Request message to the device, attempting to start 802.1X authentication.
4. The switch times out while waiting for the EAP reply, because the device does not support 802.1X.
5. The switch sends an authentication message to the authentication server, using the device MAC address as the username and password.
6. The switch authenticates or rejects the device according to the reply from the authentication server.

Section 9.1.4
VLAN Assignment with Tunnel Attributes

ROS supports assigning a VLAN to the authorized port using tunnel attributes, as defined in RFC3580, when the Port Security mode is set to 802.1X or 802.1X/MAC-Auth.

In some cases, it may be desirable to allow a port to be placed into a particular VLAN, based on the authentication result. For example:

- to allow a particular device, based on its MAC address, to remain on the same VLAN as it moves within a network, configure the switches for 802.1X/MAC-Auth mode.
- to allow a particular user, based on the user's login credentials, to remain on the same VLAN when the user logs in from different locations, configure the switches for 802.1X mode.

If the RADIUS server wants to use this feature, it indicates the desired VLAN by including tunnel attributes in the Access-Accept message. The RADIUS server uses the following tunnel attributes for VLAN assignment:

- Tunnel-Type=VLAN (13)
- Tunnel-Medium-Type=802
- Tunnel-Private-Group-ID=VLANID

Note that VLANID is 12-bits and takes a value between 1 and 4094, inclusive. The Tunnel-Private-Group-ID is a String as defined in RFC2868, so the VLANID integer value is encoded as a string.

If the tunnel attributes are not returned by the authentication server, the VLAN assigned to the switch port remains unchanged.

Section 9.2
Port Security Configuration

The Ports Security menu is accessible from the main menu.

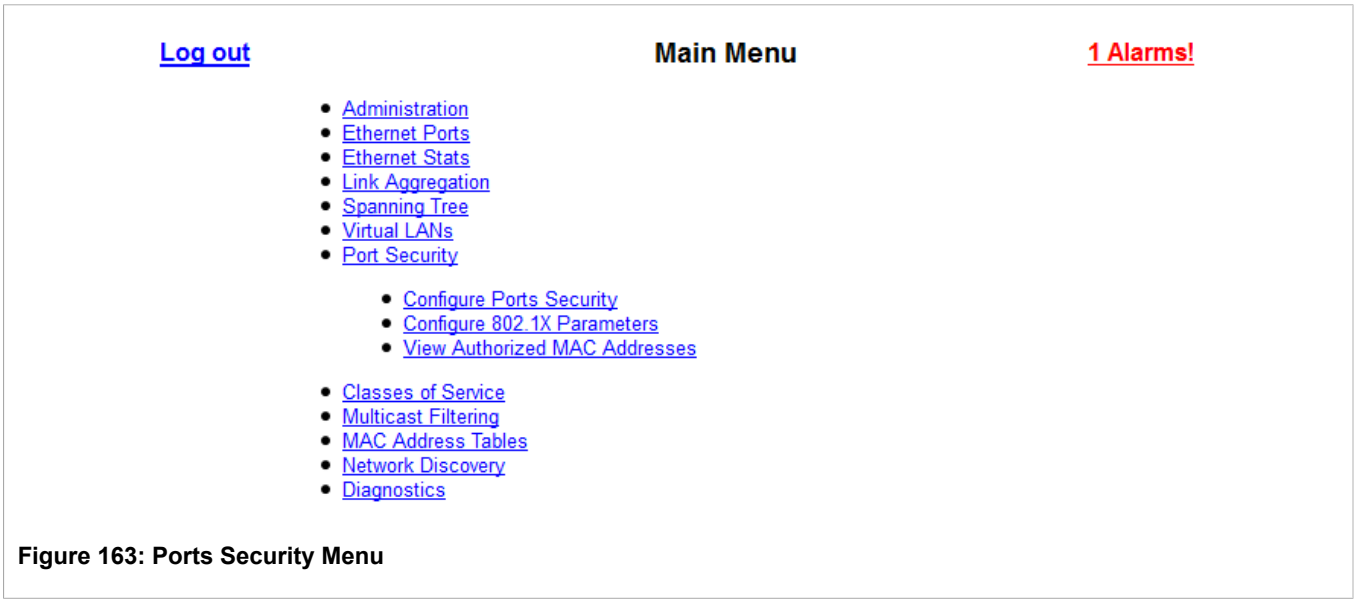
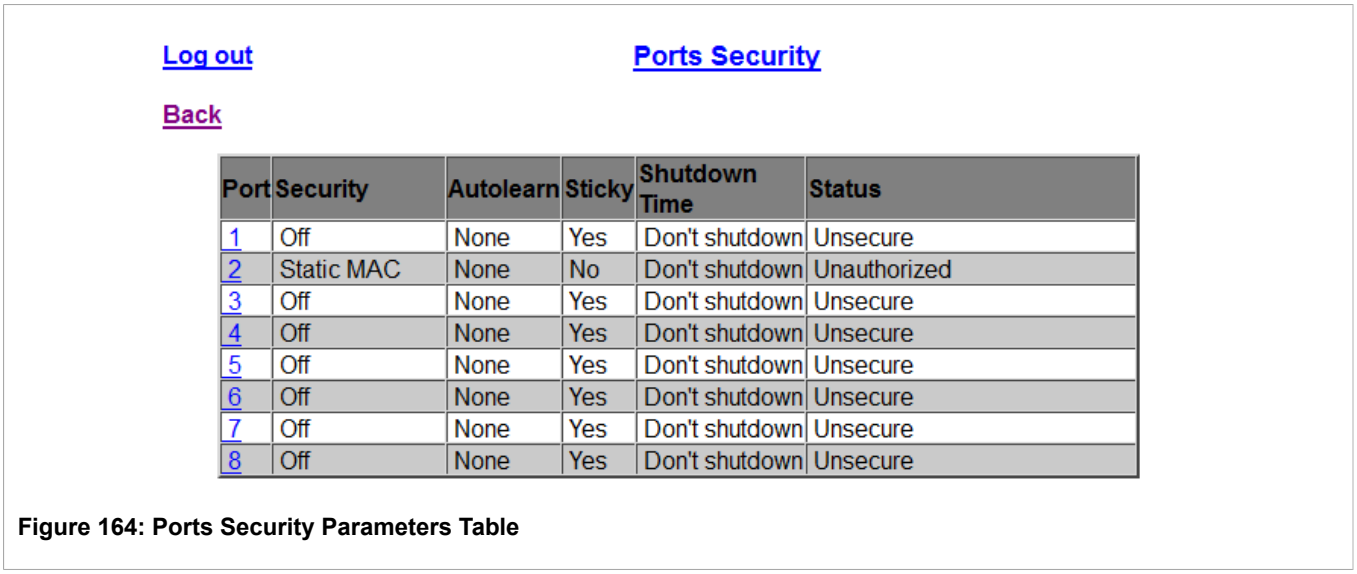


Figure 163: Ports Security Menu

Section 9.2.1
Ports Security Parameters



Port	Security	Autolearn	Sticky	Shutdown Time	Status
1	Off	None	Yes	Don't shutdown	Unsecure
2	Static MAC	None	No	Don't shutdown	Unauthorized
3	Off	None	Yes	Don't shutdown	Unsecure
4	Off	None	Yes	Don't shutdown	Unsecure
5	Off	None	Yes	Don't shutdown	Unsecure
6	Off	None	Yes	Don't shutdown	Unsecure
7	Off	None	Yes	Don't shutdown	Unsecure
8	Off	None	Yes	Don't shutdown	Unsecure

Figure 164: Ports Security Parameters Table

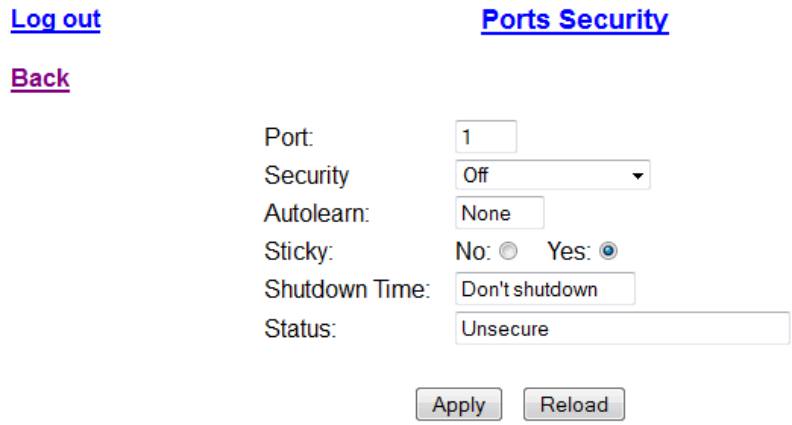
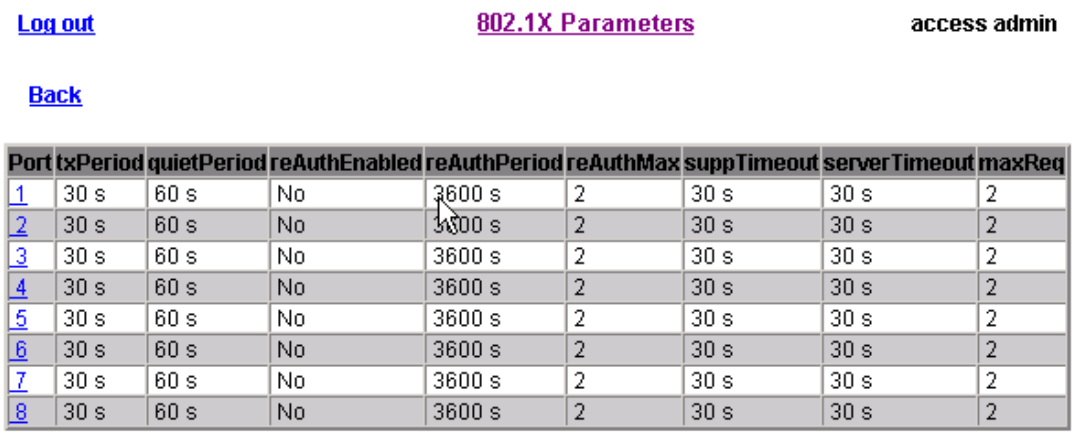


Figure 165: Ports Security Parameters Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
Security	**Synopsis:** { Off, Static MAC, 802.1X, 802.1x/MAC-Auth } **Default:** Off Enables or disables the port's security feature. Two types of port access control are available: • Static MAC address-based. With this method, authorized MAC address(es) should be configured in the Static MAC Address table. If some MAC addresses are not known in advance (or it is not known to which port they will be connected), there is still an option to configure the switch to auto-learn certain number of MAC addresses. Once learned, they do not age out until the unit is reset or the link goes down. • IEEE 802.1X standard authentication. • IEEE 802.1X with MAC-Authentication, also known as MAC-Authentication Bypass. With this option, the device can authenticate clients based on the client's MAC address if IEEE 802.1X authentication times out.
Autolearn	**Synopsis:** 1 to 16 or { None } **Default:** None Only applicable when the 'Security' field has been set to 'Static MAC'. It specifies maximum number of MAC addresses that can be dynamically learned on the port. If there are static addresses configured on the port, the actual number of addresses allowed to be learned is this number minus the number of the static MAC addresses.
Sticky	**Synopsis:** { No, Yes } **Default:** Yes Only applicable when the 'Security' field has been set to 'Static MAC'. If 'Security' is set to '802.1X', 'Sticky' is automatically forced to 'No'. Change the behaviour of the port to either sticky or non-sticky. If Sticky is 'Yes', static MAC addresses authorized on the port 'stick' to the port and the switch will not allow them to be removed from the port (in case of link down on that port) or move to a different port. If Sticky is 'No', static MAC addresses authorized on the port may move to an unsecured port. There are three scenarios in which static MAC addresses can move: • link down on a secure port • traffic switches over from a secure port to an unsecure port

Parameter	Description
	• traffic switches over from an unsecure port to a secure port, or link up on the secure port **NOTE** *The movement of static MAC addresses from one secured port to another secured port is not supported. Frames will be dropped at the new secured port.*
Shutdown Time	**Synopsis:** 1 to 86400 s or { Until reset, Don't shutdown } **Default:** Don't shutdown Specifies for how long to shut down the port, if a security violation occurs.
Status	**Synopsis:** Any 31 characters Describes the security status of the port.

Section 9.2.2
802.1X Parameters



Port	txPeriod	quietPeriod	reAuthEnabled	reAuthPeriod	reAuthMax	suppTimeout	serverTimeout	maxReq
1	30 s	60 s	No	3600 s	2	30 s	30 s	2
2	30 s	60 s	No	3600 s	2	30 s	30 s	2
3	30 s	60 s	No	3600 s	2	30 s	30 s	2
4	30 s	60 s	No	3600 s	2	30 s	30 s	2
5	30 s	60 s	No	3600 s	2	30 s	30 s	2
6	30 s	60 s	No	3600 s	2	30 s	30 s	2
7	30 s	60 s	No	3600 s	2	30 s	30 s	2
8	30 s	60 s	No	3600 s	2	30 s	30 s	2

Figure 166: 802.1X Parameters Table

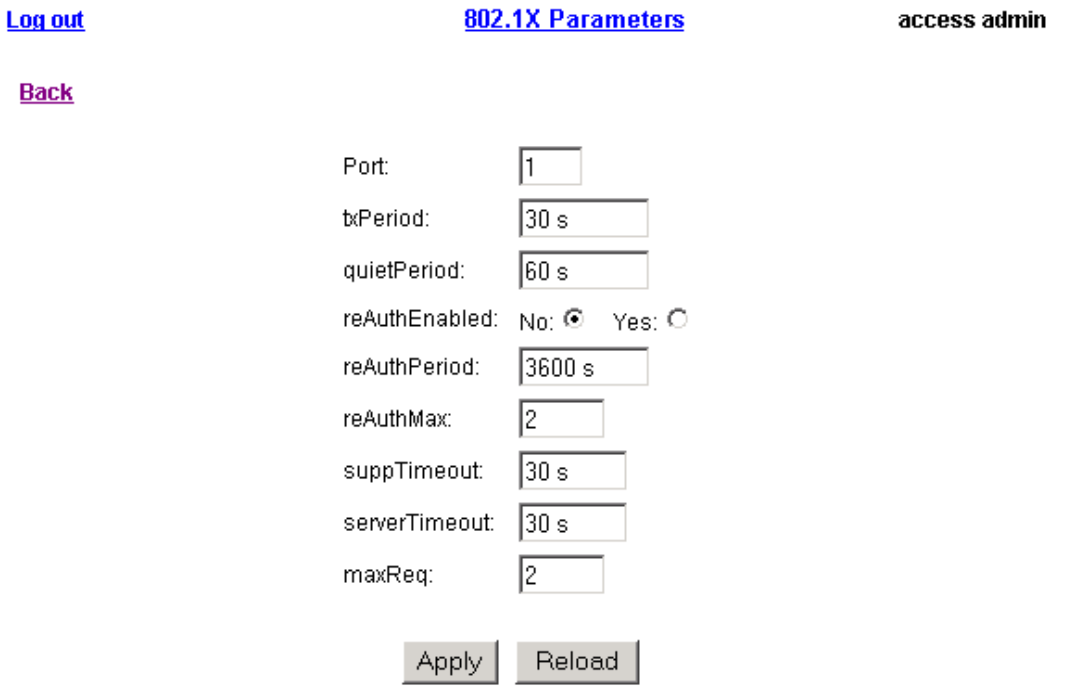


Figure 167: 802.1X Parameters Form

Parameter	Description
Port	**Synopsis:** 1 to maximum port number **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
txPeriod	**Synopsis:** 1 to 65535 **Default:** 30 s The time to wait for the Supplicant's EAP Response/Identity packet before retransmitting an EAP Request/Identity packet.
quietPeriod	**Synopsis:** 0 to 65535 **Default:** 60 s The period of time not to attempt to acquire a Supplicant after the authorization session failed.
reAuthEnabled	**Synopsis:** { No, Yes } **Default:** No Enables or disables periodic re-authentication.
reAuthPeriod	**Synopsis:** 60 to 86400 **Default:** 3600 s The time between periodic re-authentication of the Supplicant.
reAuthMax	**Synopsis:** 1 to 10 **Default:** 2 The number of re-authentication attempts that are permitted before the port becomes unauthorized.
suppTimeout	**Synopsis:** 1 to 300 **Default:** 30 s

Parameter	Description
	The time to wait for the Supplicant's response to the authentication server's EAP packet.
serverTimeout	**Synopsis:** 1 to 300 **Default:** 30 s The time to wait for the authentication server's response to the Supplicant's EAP packet.
maxReq	**Synopsis:** 1 to 10 **Default:** 2 The maximum number of times to retransmit the authentication server's EAP Request packet to the Supplicant before the authentication session times out.

Section 9.2.3
Viewing Authorized MAC Addresses

The **Authorized MAC Address Table** lists the static MAC addresses learned from secure ports.

NOTE
*Only MAC addresses authorized on a static MAC port(s) are shown in the **Authorized MAC Address Table**. MAC addresses authorized with 802.1X or 802.1X MAC AUTH are not shown.*

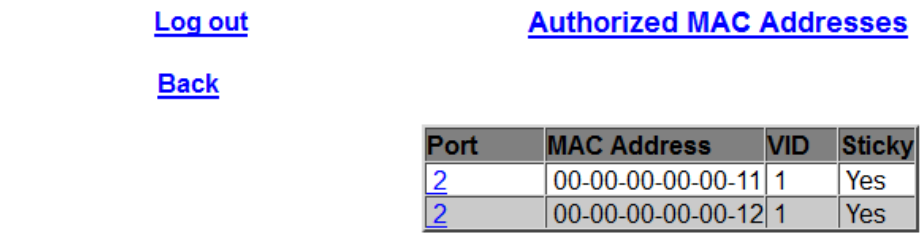


Figure 168: Authorized MAC Addresses Table

Parameter	Description
Port	**Synopsis:** 0 to 4294967295 Port on which MAC address has been learned.
MAC Address	**Synopsis:** ##-##-##-##-##-## where ## ranges 0 to FF Authorized MAC address learned by the switch.
VID	**Synopsis:** 0 to 65535 VLAN Identifier of the VLAN upon which the MAC address operates.
Sticky	**Synopsis:** { No, Yes } This describes whether the authorized MAC address/Device can move to an unsecured port or not: • YES - authorized MAC address/Device cannot move to a different switch port or be removed from the port in case of link down on the port • NO - authorized MAC address/Device may move to an unsecured switch port or be removed from the port in case of link down on the port

10 Classes of Service

ROS CoS provides the following features:

- Support for 4 Classes of Service
- Ability to prioritize traffic by ingress port.
- Ability to prioritize traffic by the priority field in 802.1Q tags.
- Ability to prioritize traffic based on its source or destination MAC address.
- Ability to prioritize traffic by the TOS field in the IP header.

Section 10.1
CoS Operation

CoS provides the ability to expedite the transmission of certain frames and port traffic over others.

The CoS of a frame can take on one of four values: Normal, Medium, High or Critical.

The default policies of the switch enforce a Normal CoS for all traffic.

NOTE
Use the highest supported CoS with caution, as it is always used by the switch for handling network management traffic such as STP BPDUs.

If this CoS is used for regular network traffic, upon traffic bursts, it may result in loss of some network management frames which in its turn may result in loss of connectivity over the network.

The CoS feature has two main phases - inspection and forwarding:

Section 10.1.1
Inspection Phase

In the inspection phase, the CoS priority of a received frame is determined from:

- The priority field in 802.1Q tags
- The Differentiated Services Code Point (DSCP) component of the Type Of Service (TOS) field, if the frame is IP
- The default CoS for the port
- >A specific CoS based upon the source and destination MAC address (as set in the Static MAC Address Table)

Note that a frame's CoS will be determined once the first examined parameter is found in the frame.

Received frames are first examined to determine if their destination or source MAC address is found in the Static MAC Address Table. If yes, the CoS configured for the static MAC address is used. If neither destination or source MAC address is in the Static MAC Address Table, the frame is then examined for 802.1Q tags and the priority field is mapped to a CoS. If a tag is not present, the frame is examined to determine if it is an IP frame. If

the frame is IP and inspecting TOS is enabled, the CoS is determined from the DSCP field. If the frame is not IP or inspecting TOS is disabled, the default CoS for the port is used.

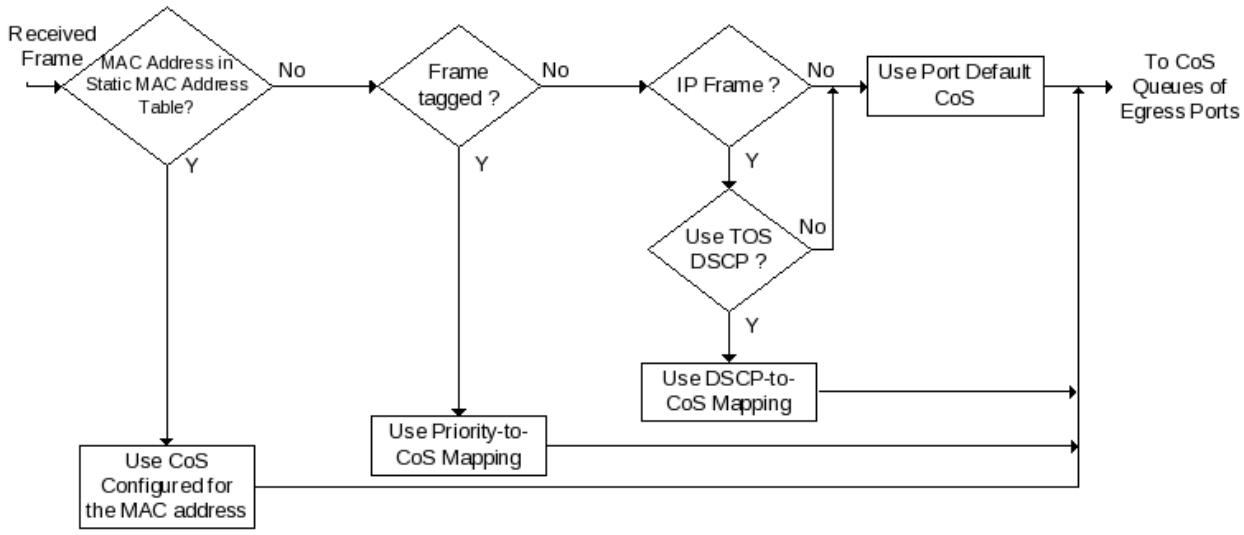


Figure 169: Determining The CoS Of A Received Frame

After inspection, the frame is the forwarded to the egress port for transmission.

Section 10.1.2

Forwarding Phase

The inspection phase results in the CoS of individual frames being determined. When these frames are forwarded to the egress port, they are collected into one of the priority queues according to the CoS assigned to each frame.

CoS weighting selects the degree of preferential treatment that is attached to different priority queues. The ratio of the number of higher CoS to lower CoS frames transmitted can be programmed. If desired, the user can program lower CoS frames are to be transmitted only after all higher CoS frames have been serviced.

Section 10.2

CoS Configuration

The Classes Of Service menu is accessible from the main menu.

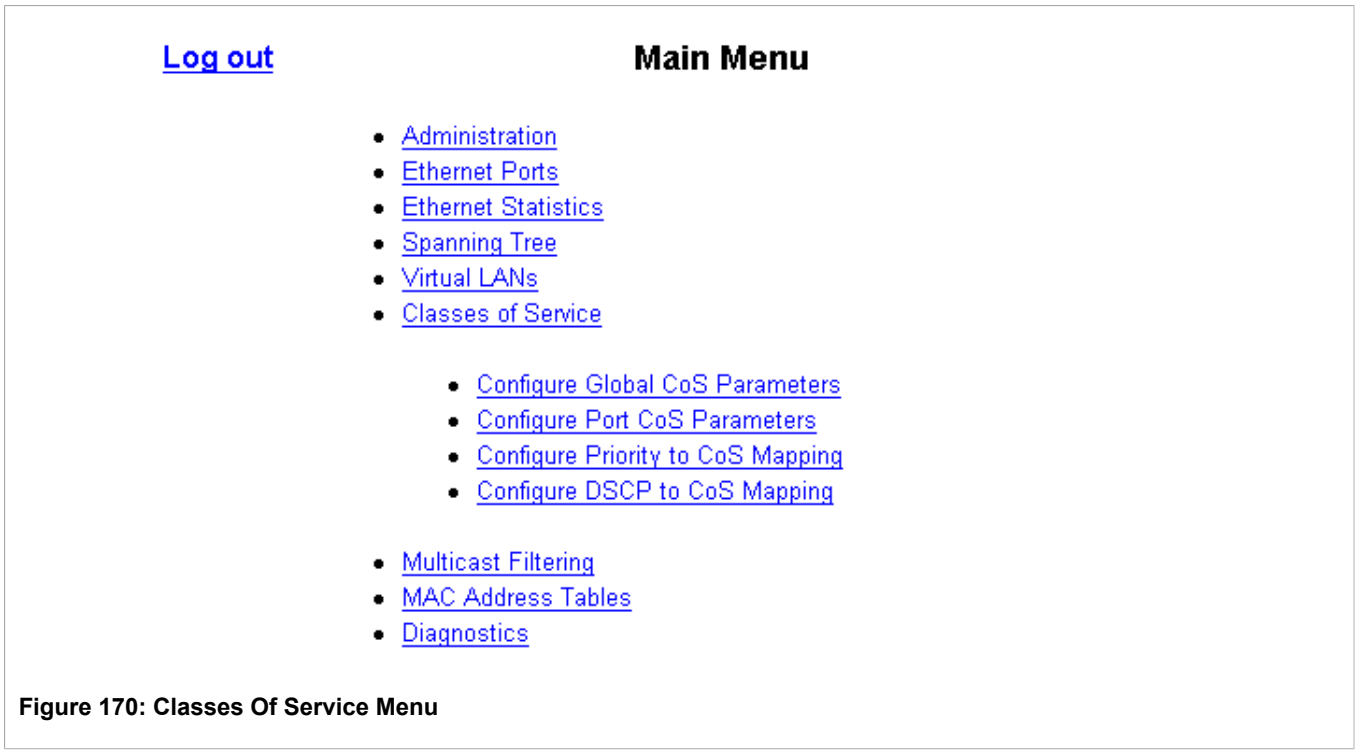


Figure 170: Classes Of Service Menu

Section 10.2.1

Global CoS Parameters

Figure 171: Global CoS Parameters Form

Parameter	Description
CoS Weighting	Synopsis: { 8:4:2:1, Strict } Default: 8:4:2:1 During traffic bursts, frames queued in the switch pending transmission on a port may have different CoS priorities. This parameter specifies weighting algorithm for transmitting different priority CoS frames. Examples: 8:4:2:1 - 8 Critical, 4 High, 2 Medium and 1 Normal priority CoS frame

Parameter	Description
	Strict - lower priority CoS frames will be only transmitted after all higher priority CoS frames have been transmitted.

Section 10.2.2
Port CoS Parameters

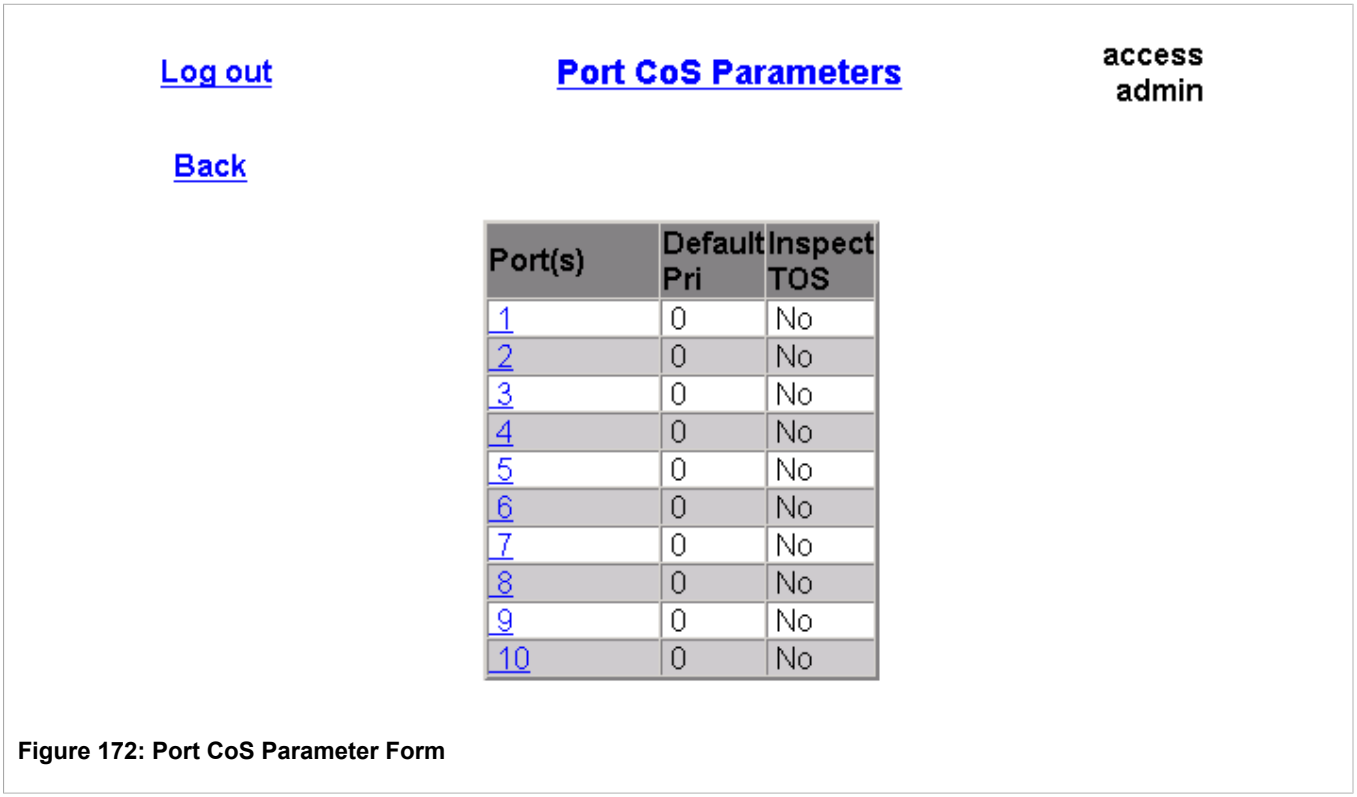


Figure 172: Port CoS Parameter Form

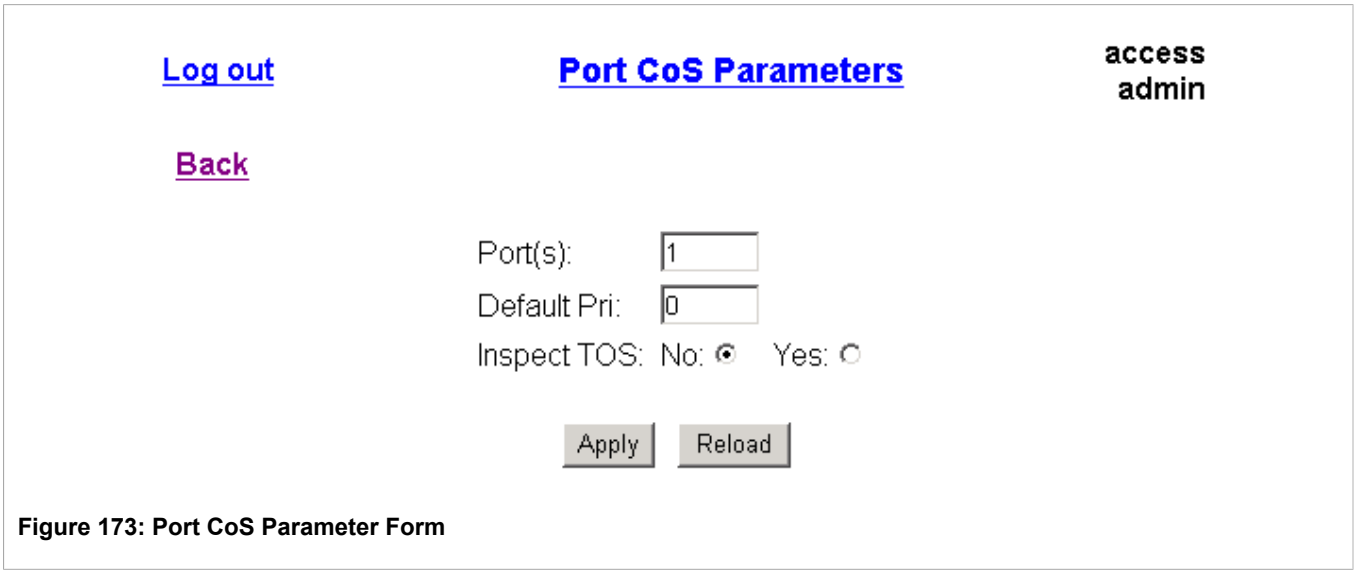


Figure 173: Port CoS Parameter Form

Parameter	Description
Port(s)	**Synopsis:** 1 to maximum port number The port number as seen on the front plate silkscreen of the switch (or a list of ports, if aggregated in a port trunk).
Default Pri	**Synopsis:** 0 to 7 **Default:** 0 This parameter allows prioritization of the frames received on this port that are not prioritized based on the frames' contents (e.g. priority field in the VLAN tag, DiffServ field in the IP header, prioritized MAC address).
Inspect TOS	**Synopsis:** { No, Yes } **Default:** No This parameter enables or disables parsing of the Type-Of-Service (TOS) field in the IP header of the received frames to determine the Class of Service that should be assigned. When TOS parsing is enabled, the switch will use the Differentiated Services bits in the TOS field.

Section 10.2.3

Priority to CoS Mapping

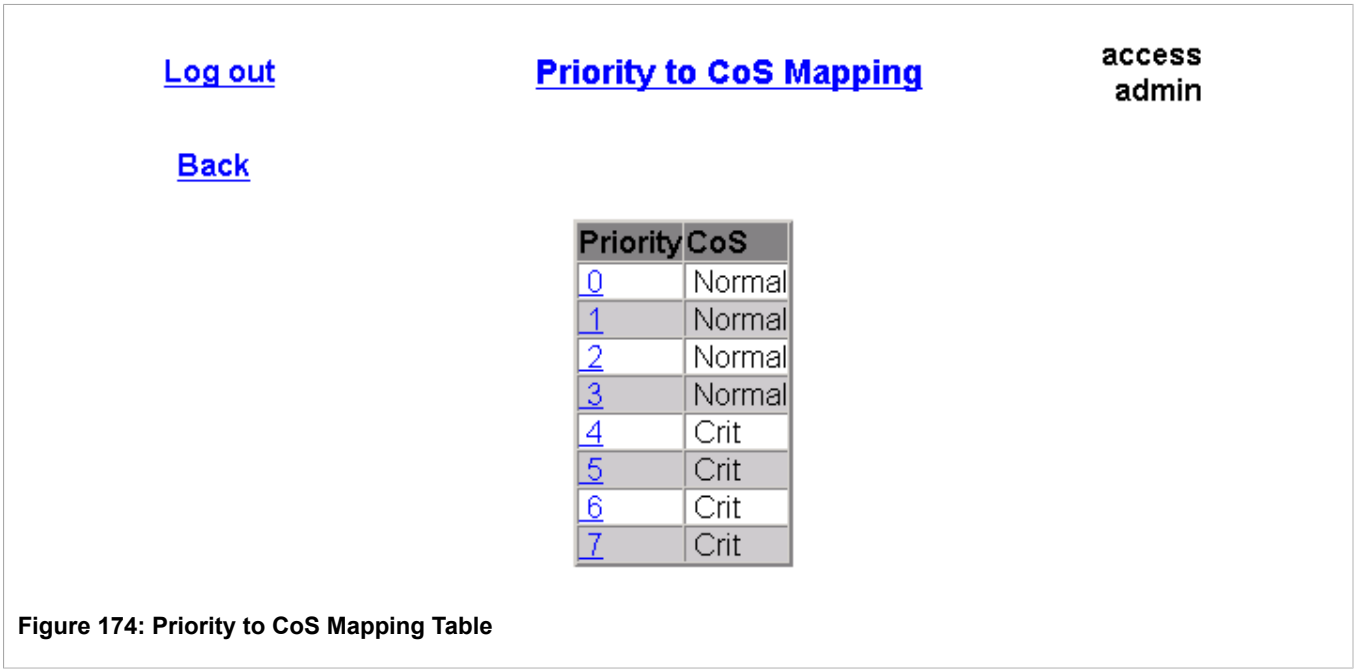


Figure 174: Priority to CoS Mapping Table

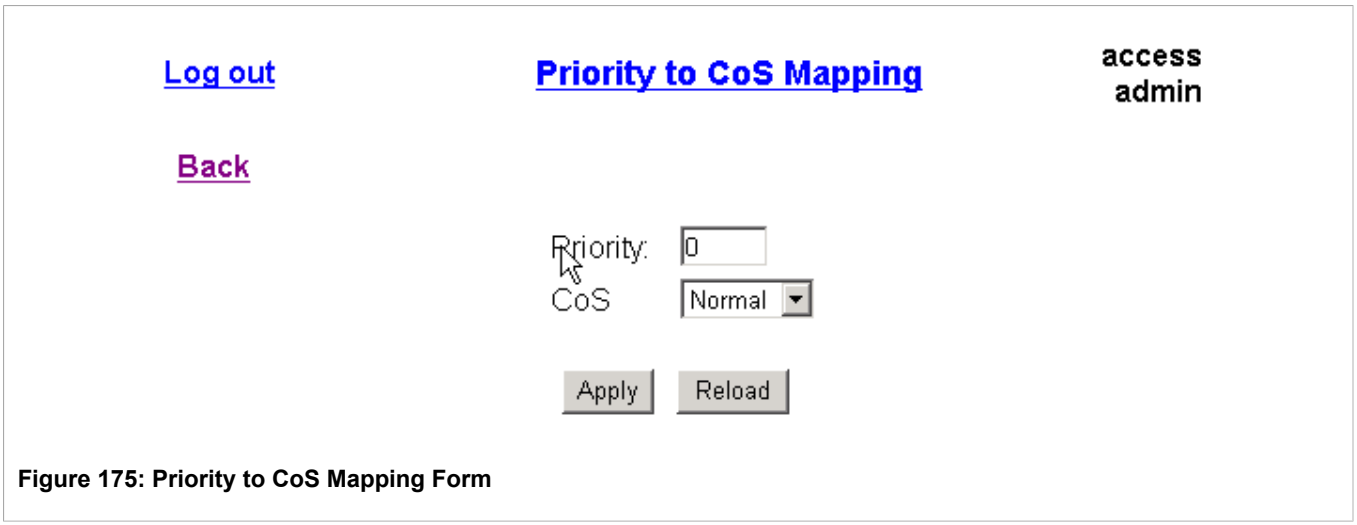


Figure 175: Priority to CoS Mapping Form

Parameter	Description
Priority	**Synopsis:** 0 to 7 **Default:** 0 This is a value of the IEEE 802.1p priority.
CoS	Synopsis: { Normal, Medium, High, Crit } **Default:** Normal This is a CoS assigned to received tagged frames with the specified IEEE 802.1p priority value.

Section 10.2.4

DSCP to CoS Mapping

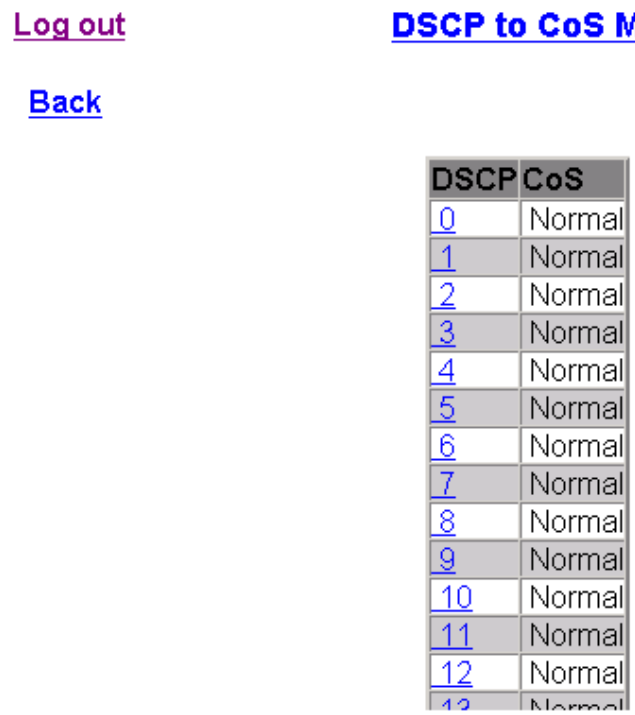


Figure 176: TOS DSCP to CoS Mapping Table

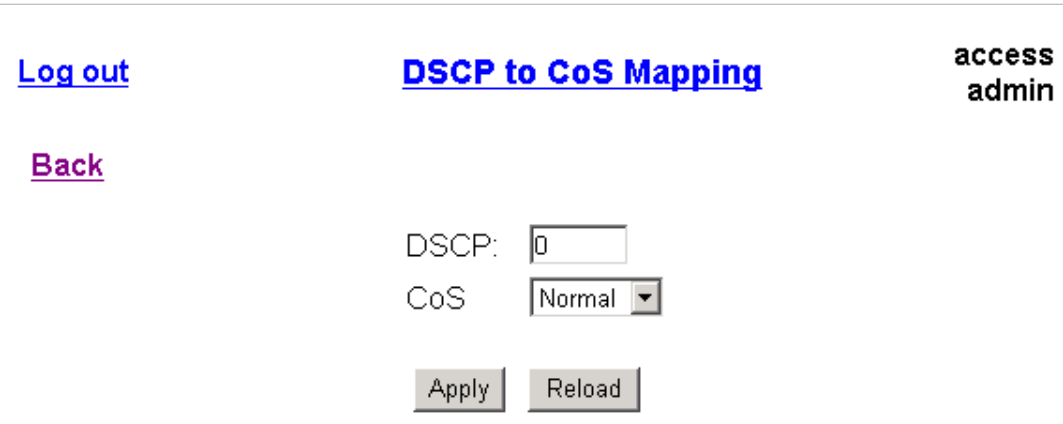


Figure 177: TOS DSCP to CoS Mapping Form

Parameter	Description
DSCP	**Synopsis:** 0 to 63 **Default:** 0 This is a Differentiated Services Code Point (DSCP) - a value of the 6-bit DiffServ field in the Type-Of-Service (TOS) field of the IP header.
CoS	Synopsis: { Normal, Medium, High, Crit }

Parameter	Description
	Default: Normal This is a Class of Service assigned to received frames with the specified DSCP.

11 Multicast Filtering

ROS Multicast Filtering provides the following features:

- Support for up to 256 Multicast Groups (either static or dynamic).
- Ability to prioritize a Static Multicast Group via Class-of-Service.
- Industry standard support of IGMP (RFC 1112, RFC 2236) versions 1 and 2 in active and passive roles.
- Support of IEEE 802.1Q-2005 standard GMRP (GARP Multicast Registration protocol).
- Ability to enable or disable IGMP on a per VLAN basis.
- Multicast routers may be statically configured or dynamically recognized by IGMP.
- "Routerless" IGMP operation.

ROS performs Multicast Filtering using the following methods:

- Static Multicast Groups.
- Internet Group Management Protocol (IGMP) snooping.
- IEEE standard GARP Multicast Registration protocol (GMRP).

NOTE
ROS IGMP Snooping supports multicast routers using IGMP version 2 and hosts using either IGMP version 1 or 2.

Section 11.1
IGMP

IGMP is used by IP hosts to report their host group memberships to multicast routers. As hosts join and leave specific multicast groups, streams of traffic are directed to or withheld from that host.

The IGMP protocol operates between multicast routers and IP hosts. When an unmanaged switch is placed between multicast routers and their hosts, the multicast streams will be distributed to all ports. This may introduce significant traffic onto ports that do not require it and receive no benefit from it.

RUGGEDCOM products with IGMP Snooping enabled will act on IGMP messages sent from the router and the host, restricting traffic streams to the appropriate LAN segments.

Section 11.1.1
Router and Host IGMP Operation

The network shown in Figure 178, “IGMP Operation Example 1” provides a simple example of the use of IGMP. One “producer” IP host (P1) is generating two IP multicast streams, M1 and M2. There are four potential “consumers” of these streams, C1 through C4.

The multicast router discovers which host wishes to subscribe to which stream by sending general membership queries to each of the segments.

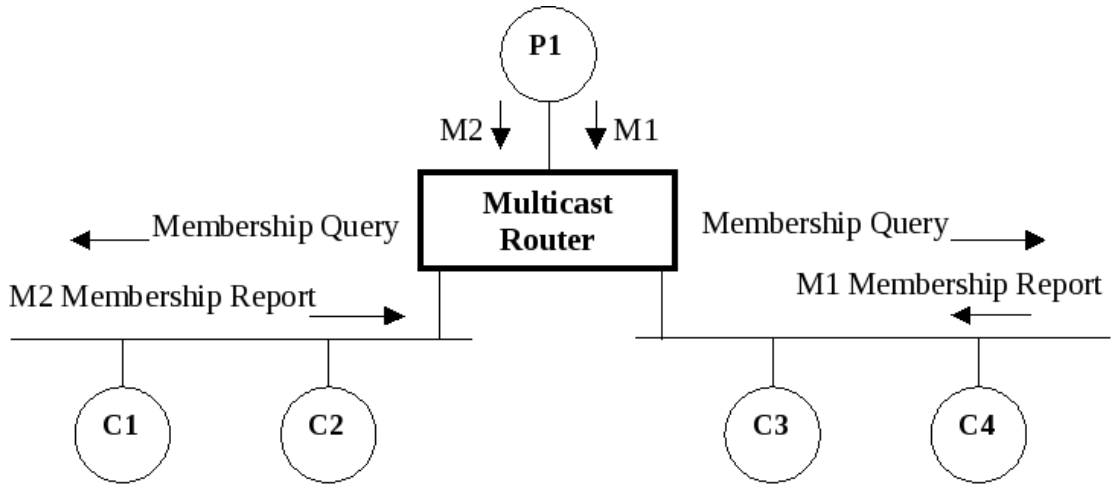


Figure 178: IGMP Operation Example 1

In this example, the general membership query indicating the desire to subscribe to a stream M2. The router will forward the M2 stream onto the C1-C2 segment. In a similar fashion, the router discovers that it must forward M1 onto segment C3-C4.

NOTE
Membership reports are also referred to as "joins".

A "consumer" may join any number of multicast groups, issuing a membership report for each group. When a host issues a membership report, other hosts on the same network segment that also require membership to the same group suppress their own requests, since they would be redundant. In this way, the IGMP protocol guarantees that the segment will issue only one join for each group.

The router periodically queries each of its segments in order to determine whether at least one consumer still subscribes to a given stream. If it receives no responses within a given timeout period (usually two query intervals), the router will prune the multicast stream from the given segment.

A more usual method of pruning occurs when consumers wishing to un-subscribe issue an IGMP "leave group" message. to determine whether there are any remaining subscribers of that group on the segment. After the last consumer of a group has un-subscribed, the router will prune the multicast stream from the given segment.

Section 11.1.2
Switch IGMP Operation

The IGMP Snooping feature provides a means for switches to snoop (i.e. watch) the operation of routers, respond with joins/leaves on the behalf of consumer ports and to prune multicast streams accordingly.

There are two modes of IGMP that the switch can be configured to assume - active and passive.

Active Mode

ROS IGMP supports "routerless" mode of operation.

When such a switch is used without a multicast router, it is able to function as if it is a multicast router sending IGMP general queries.

Passive Mode

When such a switch is used in a network with a multicast router, it can be configured to run Passive IGMP. This mode prevents the switch from sending the queries that can confuse the router causing it to stop issuing IGMP queries.

NOTE

A switch running in passive mode requires the presence of a multicast router or it will not be able to forward multicast streams at all

If no multicast routers are present, at least one IGMP Snooping switch must be configured for Active IGMP mode to make IGMP functional.

IGMP Snooping Rules

- When a multicast source starts multicasting, the traffic stream will be immediately blocked on segments from which joins have not been received.
- The switch will always forward all multicast traffic to the ports where multicast routers are attached unless configured otherwise.
- Packets with a destination IP multicast address in the 224.0.0.X range which are not IGMP are always forwarded to all ports. This behavior is based on the fact that many systems do not send joins for IP multicast addresses in this range while still listening to such packets.
- The switch implements “proxy-reporting”, i.e. membership reports received from downstream are summarized and used by the switch to issue its own reports.
- The switch will only send IGMP membership reports out of those ports where multicast routers are attached because sending membership reports to hosts could result in unintentionally preventing a host from joining a specific group.
- Multicast routers use IGMP to elect a master router known as the querier – the one with the lowest IP address is elected to be the querier, all other routers become of non-queriers, participating only forward multicast traffic. Switches running in Active IGMP mode participate in the querier election like multicast routers.
- When the querier election process is complete, the switch simply relays IGMP queries received from the querier.
- When sending IGMP packets, the switch uses its own IP address, if it has one, for the VLAN on which packets are sent, or an address of 0.0.0.0, if it does not have an assigned IP address.

NOTE

IGMP Snooping switches perform multicast pruning using a multicast frame's destination MAC multicast address which depends on the group IP multicast address. For example, an IP multicast address A.B.C.D corresponds to MAC address 01-00-5E-XX-YY-ZZ, where XX corresponds to the lower 7 bits of B, and YY and ZZ are simply C and D, respectively, coded in hexadecimal.

Note also that IP multicast addresses such as 224.1.1.1 and 225.1.1.1 will both map onto the same MAC address 01-00-5E-01-01-01. This is a problem for which the IETF Network Working Group currently has no published solution. Users are advised to be aware of and avoid this problem.

IGMP and STP

An STP change of topology can render the routes selected to carry multicast traffic as incorrect. This results in lost multicast traffic.

If STP detects change in the network topology, IGMP will take some actions to avoid loss of multicast connectivity and reduce network convergence time:

- The switch will immediately issue IGMP queries (if in IGMP Active mode) to obtain potential new group membership information.
- The switch can be configured to flood multicast streams temporarily out of all ports that are not configured as STP Edge Ports.

Section 11.1.3
Combined Router and Switch IGMP Operation

This section describes the additional challenges of multiple routers, VLAN support and switching.

Producer P1 resides on VLAN 2 while P2 resides on VLAN 3. Consumer C1 resides on both VLANs whereas C2 and C3 reside on VLANs 3 and 2, respectively. Router 2 resides on VLAN 2, presumably to forward multicast traffic to a remote network or act as a source of multicast traffic itself.

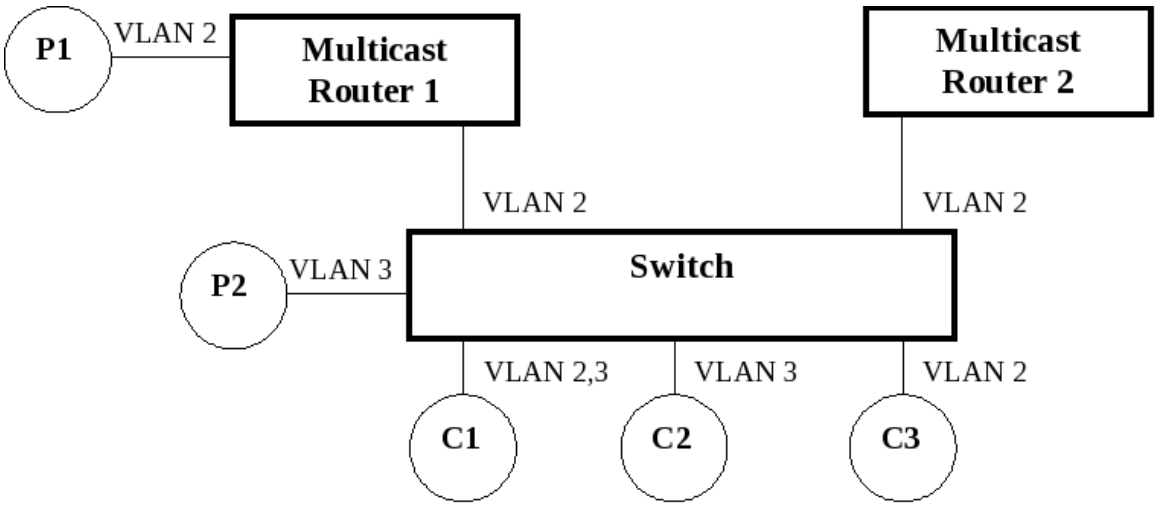


Figure 179: IGMP Operation Example 2

In this example, we will assume that all the devices agree that router 1 is the querier for VLAN 2 and router 2 is simply a non-querier. In this case, the switch will periodically receive queries from router 1 and, thus, maintain the information concerning which of its ports links to the multicast router. However, the switch port that links to router 2 must be manually configured as a “router port”. Otherwise, the switch will send neither multicast streams nor joins/leaves to router 2.

Note that VLAN 3 does not have an external multicast router. The switch should be configured to operate in its "routerless" mode and issue general membership queries as if it is the router.

Processing Joins

If host C1 desires to subscribe to the multicast streams for both P1 and P2, it will generate two joins. The join from C1 on VLAN 2 will cause the switch to immediately initiate its own join to multicast router 1 (and to issue its own join as a response to queries).

The join from C1 for VLAN 3 will cause the switch to immediately begin forwarding multicast traffic from P2 to C1.

Processing Leaves

When host C1 decides to leave a multicast group, it will issue a leave request to the switch. The switch will poll the port to determine if C1 is the last member of the group on that port. If C1 is the last (or only) member, the group will immediately be pruned from the port.

Should host C1 leave the multicast group without issuing a leave group message and then fail to respond to a general membership query, the switch will stop forwarding traffic after two queries.

When the last port in a multicast group leaves the group (or is aged-out), the switch will issue an IGMP leave report to the router.

Section 11.2

GMRP (GARP Multicast Registration Protocol)

The GARP Multicast Registration Protocol (GMRP) is an application of the Generic Attribute Registration Protocol (GARP) that provides a mechanism at Layer 2 for managing multicast group membership in a bridged Layer 2 network. It allows Ethernet switches and end stations to register and unregister membership in multicast groups with other switches on a LAN, and for that information to be disseminated to all switches in the LAN that support Extended Filtering Services.

GMRP is an industry-standard protocol first defined in IEEE 802.1D-1998 and extended in IEEE 802.1Q-2005. GARP was defined in IEEE 802.1D-1998 and updated in 802.1D-2004. Note that GMRP provides similar functionality at Layer 2 to that which IGMP, described in the preceding sections, provides at Layer 3.

Section 11.2.1

Joining a Multicast Group

In order to join a multicast group, an end station transmits a GMRP “join” message. The switch that receives the “join” message adds the port through which the message was received to the multicast group specified in the message. It then propagates the “join” message to all other hosts in the VLAN, one of which is expected to be the multicast source.

When a switch transmits GMRP updates (from GMRP-enabled ports), all of the multicast groups known to the switch, whether configured manually or learned dynamically through GMRP, are advertised to the rest of network.

As long as one host on the Layer 2 network has registered for a given multicast group, traffic from the corresponding multicast source will be carried on the network. Traffic multicast by the source is only forwarded by each switch in the network to those ports from which it has received join messages for the multicast group.

Section 11.2.2

Leaving a Multicast Group

Periodically, the switch sends GMRP queries in the form of a “leave all” message. If a host (either a switch or an end station) wishes to remain in a multicast group, it reasserts its group membership by responding with an appropriate “join” request. Otherwise, it can either respond with a “leave” message or simply not respond at all. If the switch receives a “leave” message or receives no response from the host for a timeout period, the switch removes the host from the multicast group.

Section 11.2.3

GMRP Protocol Notes

Since GMRP is an application of GARP, transactions take place using the GARP protocol. GMRP defines the following two Attribute Types:

- The *Group Attribute Type*, used to identify the values of group MAC addresses
- The *Service Requirement Attribute Type*, used to identify service requirements for the group

Service Requirement Attributes are used to change the receiving port's multicast filtering behavior to one of the following:

- Forward All Multicast group traffic in the VLAN, or
- Forward All Unknown Traffic (Multicast Groups) for which there are no members registered in the device in a VLAN

If GMRP is globally disabled on the device, GMRP PDUs received by the switch are forwarded like any other traffic. However, if GMRP is globally enabled, then GMRP packets are processed by the switch and are not forwarded.

If STP detects change in the network topology, the switch can be configured to flood multicast streams temporarily out of all ports that are not configured as STP Edge Ports.

Section 11.2.4

GMRP Example

In the example depicted in Figure 180, "Example using GMRP", there are two multicast sources, S1 and S2, multicasting to Multicast Groups 1 and 2, respectively. A network of five switches, including one core Switch, B, connects the sources to two hosts, H1 and H2, which receive the multicast streams from S1 and S2, respectively.

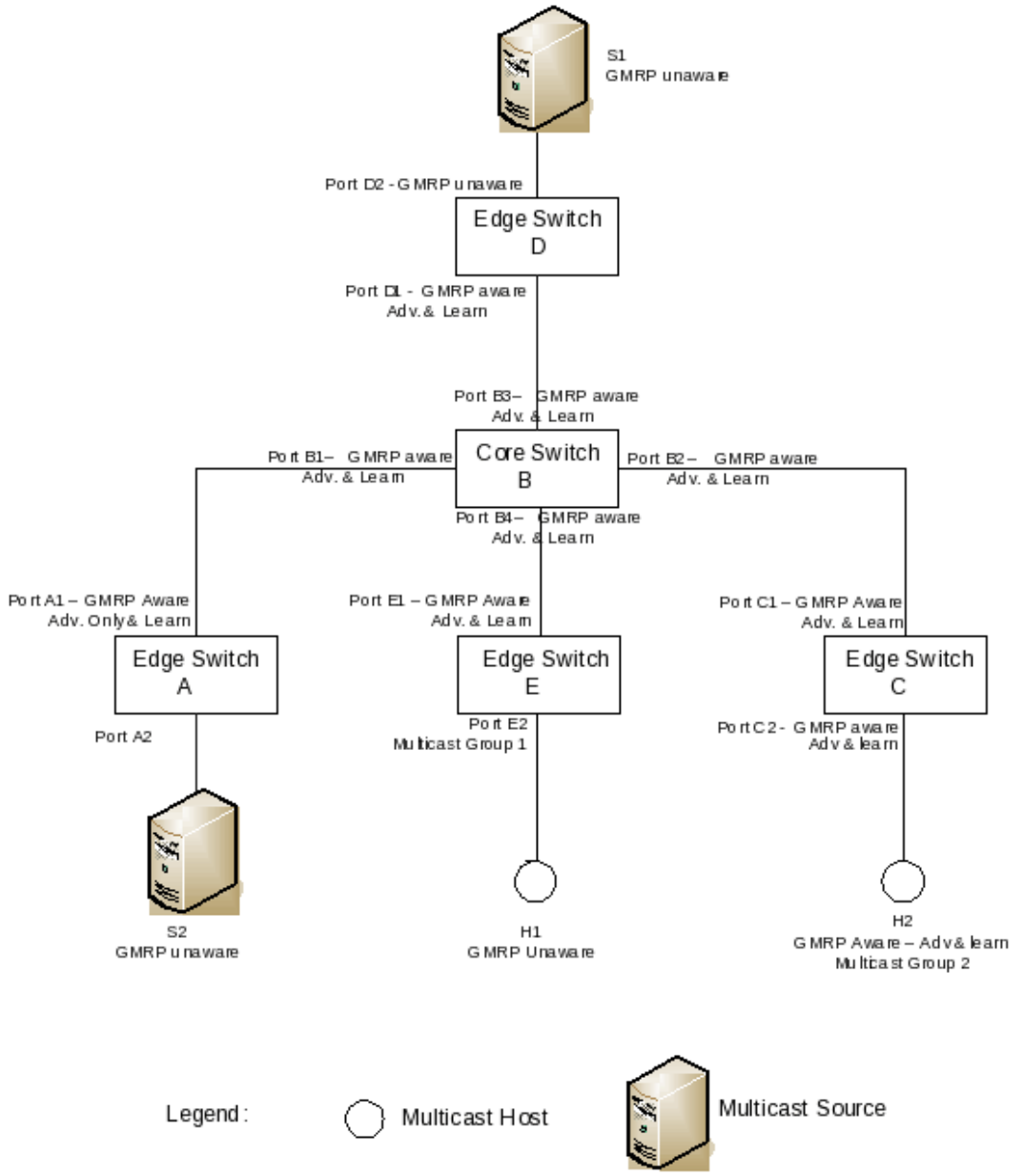

S1
GMRP unaware
Port D2 - GMRP unaware
Edge Switch D
Port D1 - GMRP aware Adv.& Learn
Port B3– GMRP aware Adv. & Learn
Port B1– GMRP aware Adv. & Learn
Core Switch B
Port B2– GMRP aware Adv. & Learn
Port B4– GMRP aware Adv. & Learn
Port A1 – GMRP Aware Adv. Only& Learn
Port E1 – GMRP Aware Adv. & Learn
Port C1 – GMRP Aware Adv. & Learn
Edge Switch A
Edge Switch E
Edge Switch C
Port A2
Port E2 Multicast Group 1
Port C2 - GMRP aware Adv & learn
S2
GMRP unaware
H1
GMRP Unaware
H2
GMRP Aware – Adv& learn Multicast Group 2
Legend :
Multicast Host
Multicast Source

Figure 180: Example using GMRP

Joining the Multicast Groups:

The sequence of events surrounding the establishment of membership for the two Multicast Groups on the example network is as follows:

- Host H1 is GMRP unaware but needs to see traffic for Multicast Group 1. Port E2 on Switch E, therefore, is statically configured to forward traffic for Multicast Group 1.
- Switch E advertises membership in Multicast Group 1 to the network through Port E1, making Port B4 on Switch B a member of Multicast Group 1.
- Switch B propagates the “join” message, causing Port D1 on Switch D to become a member of Multicast Group 1. Note that ports A1 and C1 also become members.

- Host H2 is GMRP-aware and sends a “join” request for Multicast Group 2 to Port C2, which thereby becomes a member of Group 2.
- Switch C propagates the “join” message, causing Port B2 on Switch B and Port A1 on Switch A to become members of Multicast Group 2. Note that ports D1 and E1 also become members.

Multicast Traffic on the Network

Once GMRP-based registration has propagated through the network as described above, multicasts from S1 and S2 can reach their destinations, as described in the following:

- Source S1 transmits multicast traffic to Port D2 which is forwarded via Port D1, which has previously become a member of Multicast Group 1.
- Switch B forwards the Group 1 multicast via Port B4 towards Switch E.
- Switch E forwards the Group 1 multicast via Port E2, which has been statically configured for membership in Multicast Group 1.
- Host H1, connected to Port E2, thus receives the Group 1 multicast.
- Source S2 transmits multicast traffic to Port A2, which is then forwarded via port A1, which has previously become a member of Multicast Group 2.
- Switch B forwards the Group 2 multicast via Port B2 towards Switch C.
- Switch C forwards the Group 2 multicast via Port C2, which has previously become a member of Group 2.
- Ultimately, Host H2, connected to Port C2, receives the Group 2 multicast.

Section 11.3

Multicast Filtering Configuration and Status

The Multicast Filtering menu is available from the main menu.

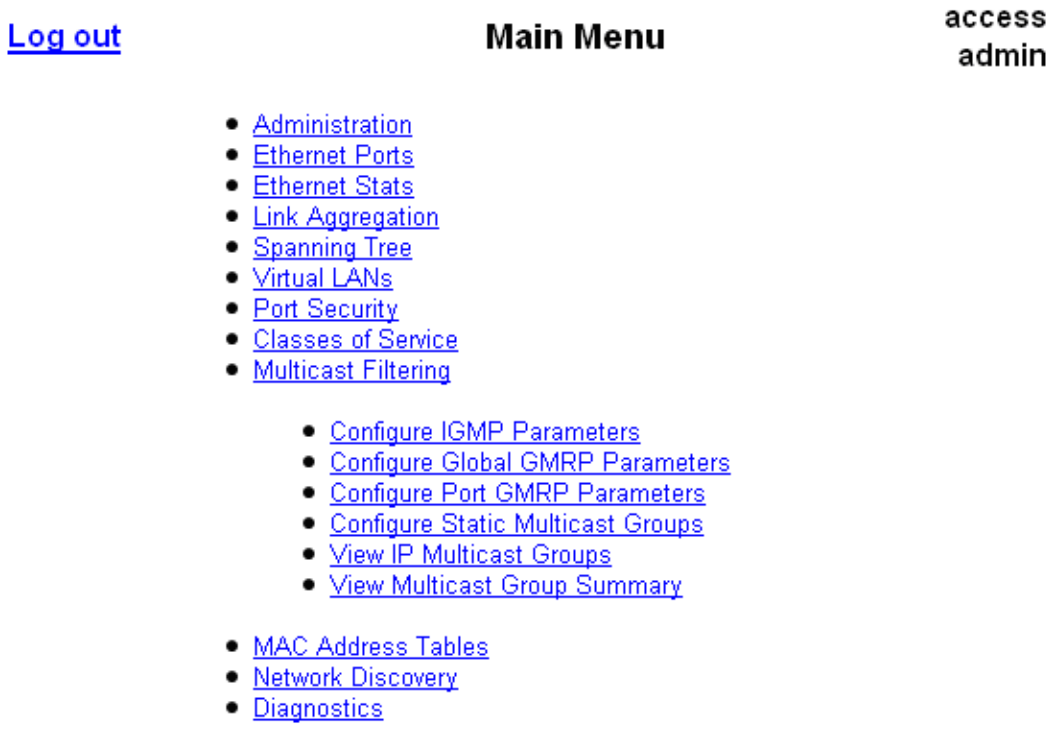


Figure 181: Multicast Filtering Menu

Section 11.3.1

Configuring IGMP Parameters

Note that the activation of IGMP on a per-VLAN basis is configured using Static VLANs.

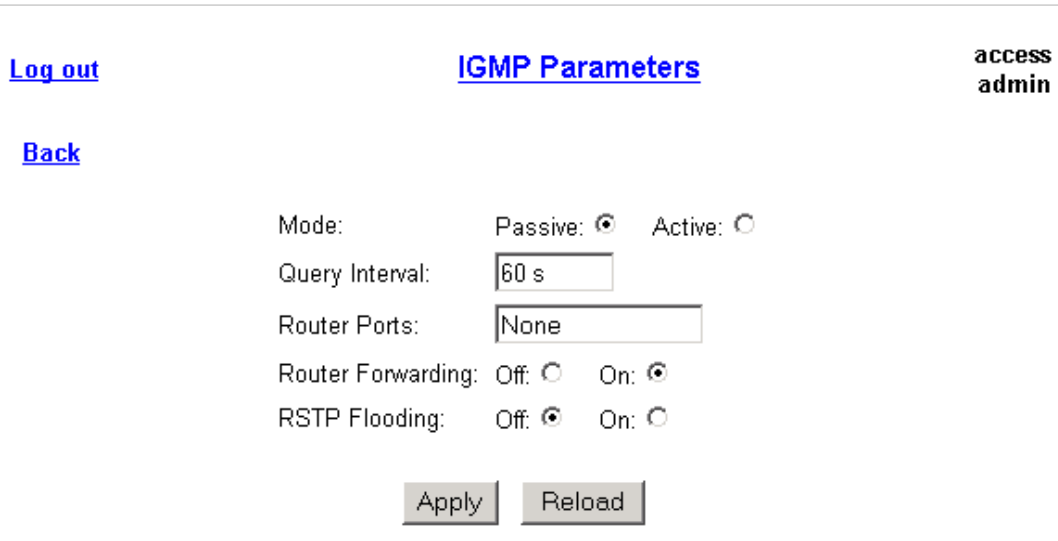


Figure 182: IGMP Parameter Form

Parameter	Description
Mode	**Synopsis:** { Passive, Active } **Default:** Passive Specifies IGMP mode: PASSIVE - the switch passively snoops IGMP traffic and never sends IGMP queries ACTIVE - the switch generates IGMP queries, if no queries from a better candidate for being the querier are detected for a while.
Query Interval	**Synopsis:** 10 to 3600 **Default:** 60 s The time interval between IGMP queries generated by the switch. **NOTE** *This parameter also affects the Group Membership Interval (i.e. the group subscriber aging time), therefore, it takes effect even in PASSIVE mode.*
Router Ports	**Synopsis:** Any combination of numbers valid for this parameter **Default:** None This parameter specifies ports that connect to multicast routers. If you do not configure known router ports, the switch may be able to detect them, however it is advisable to pre-configure them.
Router Forwarding	**Synopsis:** { Off, On } **Default:** On This parameter specifies whether multicast streams will be always forwarded to multicast routers.
STP Flooding	**Synopsis:** { Off, On } **Default:** Off This parameter specifies whether multicast streams will be flooded out of all STP non-edge ports upon topology change detection. Such flooding is desirable, if guaranteed multicast stream delivery after topology change is most important.

Section 11.3.2
Global GMRP Configuration

This menu configures GMRP parameters common to all ports on the device.

Figure 183: Global GMRP Parameter Form

Parameter	Description
GMRP-aware	**Synopsis:** { No, Yes } **Default:** No Set either GMRP-aware or GMRP-unaware mode of operation. When GMRP is globally GMRP-unaware, GMRP configurations on individual ports are ignored. When GMRP is globally GMRP-aware, each port can be individually configured.
STP-Flooding	**Synopsis:** { Off, On } **Default:** Off This parameter specifies whether multicast streams will be flooded out of all STP non-edge ports upon topology change detection. Such flooding is desirable if guaranteed multicast stream delivery after a topology change is most important.
Leave-Timer	**Synopsis:** 600 ms to 8000 ms **Default:** 4000 The time in milliseconds to wait after issuing Leave or LeaveAll before removing registered multicast groups. If Join messages for specific addresses are received before this timer expires, the addresses will be kept registered.

Section 11.3.3

Port-Specific GMRP Configuration

This menu displays a summary of GMRP settings for all ports on the device.

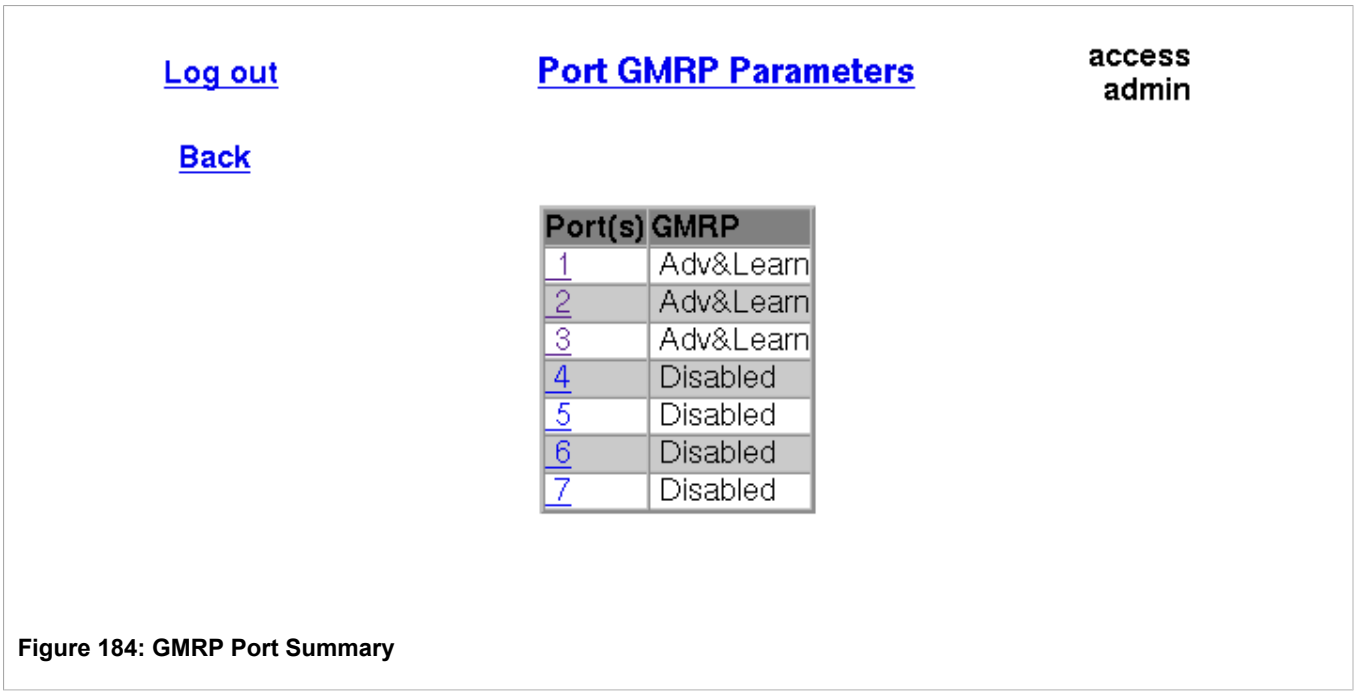


Figure 184: GMRP Port Summary

This menu configures GMRP parameters specific to a particular port on the device.

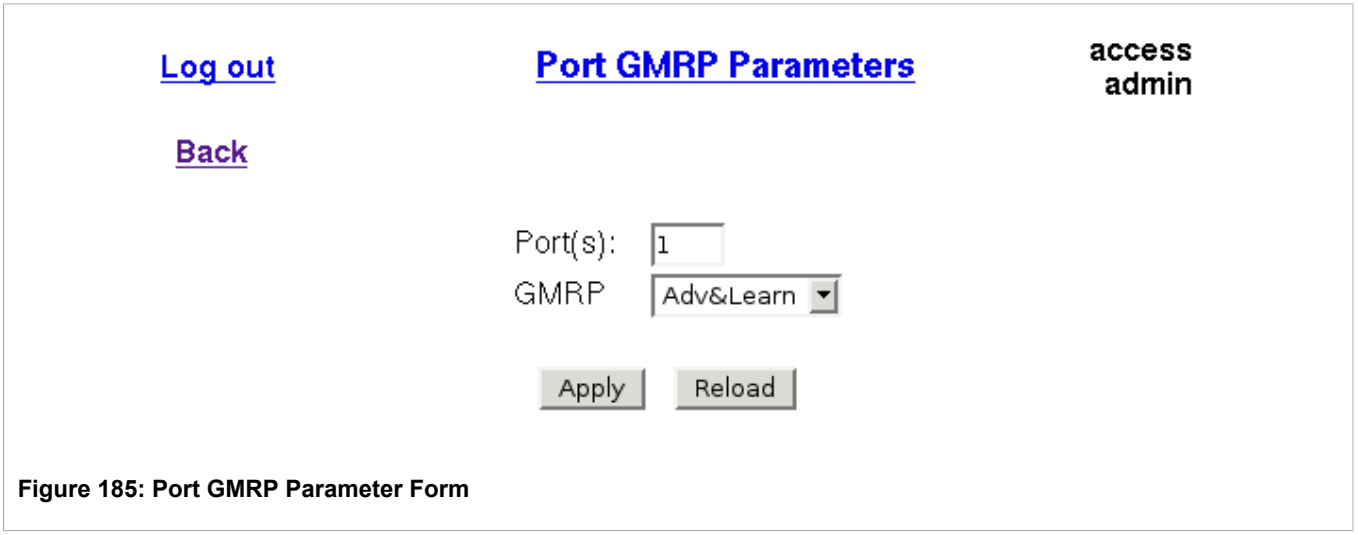


Figure 185: Port GMRP Parameter Form

Parameter	Description
Port(s)	**Synopsis:** Any combination of numbers valid for this parameter The port number as seen on the front plate silkscreen of the switch (or a list of ports, if aggregated in a port trunk).
GMRP	**Synopsis:** { Disabled, Adv Only, Adv&Learn } **Default:** Disabled Configures GMRP (GARP Multicast Registration Protocol) operation on the port. There are three GMRP modes of operation: DISABLED - the port is not capable of any GMRP processing. ADVERTISE ONLY - the port will declare all MCAST addresses existing in the switch (configured or learned) but will not learn any MCAST addresses.

Parameter	Description
	ADVERTISE & LEARN - the port will declare all MCAST Addresses existing in the switch (configured or learned) and can dynamically learn MCAST addresses.

NOTE
It is recommended to enable GMRP only on edge ports, and to disable it on trunk ports, in order to allow more rapid propagation of attribute subscription, especially after changes in network topology.

Section 11.3.4
Configuring Static Multicast Groups

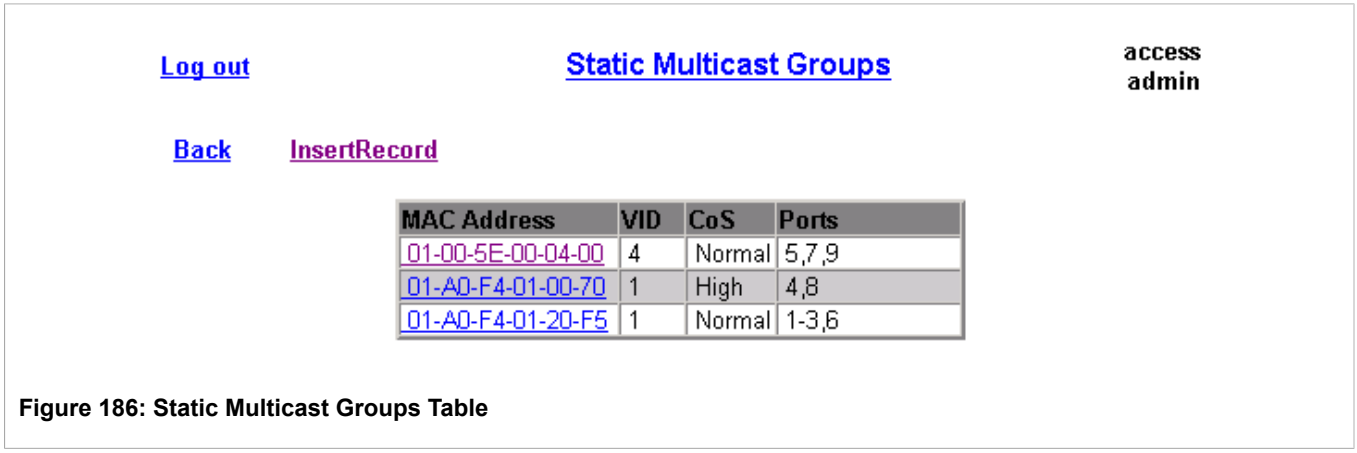


Figure 186: Static Multicast Groups Table

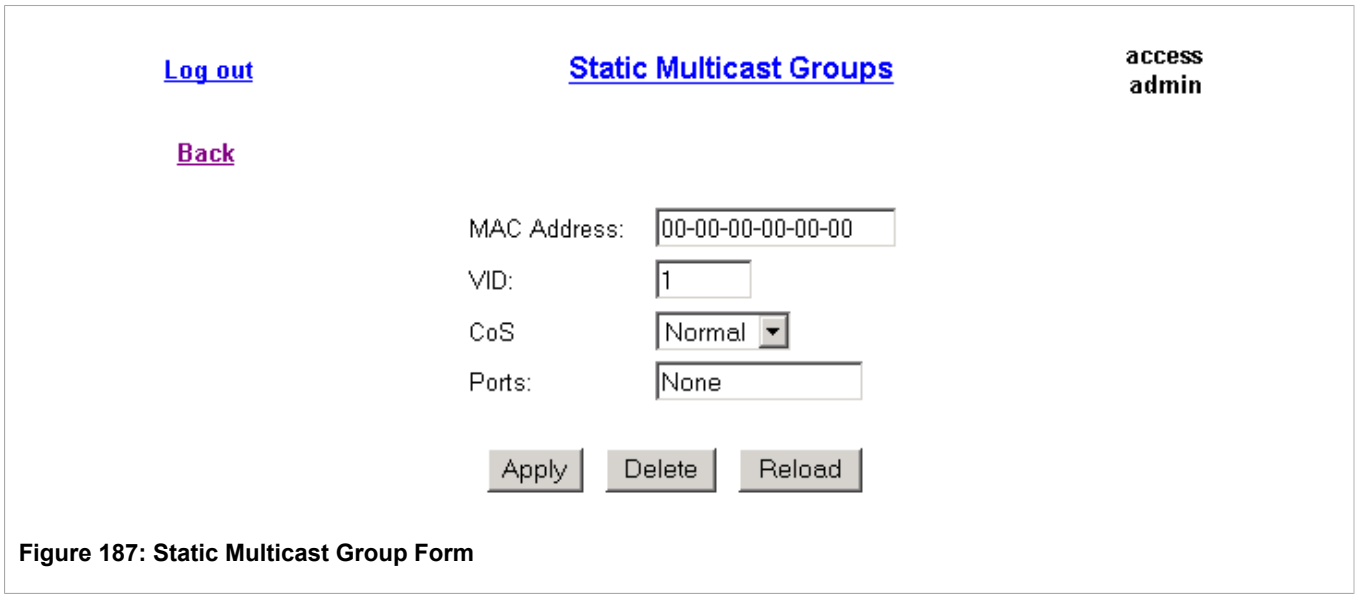


Figure 187: Static Multicast Group Form

Parameter	Description
MAC Address	**Synopsis:** ##-##-##-##-##-## where ## ranges 0 to FF **Default:** 00-00-00-00-00-00 A multicast group MAC address.
VID	Synopsis: 1 to 4094

Parameter	Description
	Default: 1 The VLAN Identifier of the VLAN on which the multicast group operates.
CoS	Synopsis: { Normal, Medium, High, Crit } **Default:** Normal Specifies what Class Of Service is assigned to the multicast group frames.
Ports	**Synopsis:** Any combination of numbers valid for this parameter **Default:** None The ports to which the multicast group traffic is forwarded.

Section 11.3.5

Viewing IP Multicast Groups

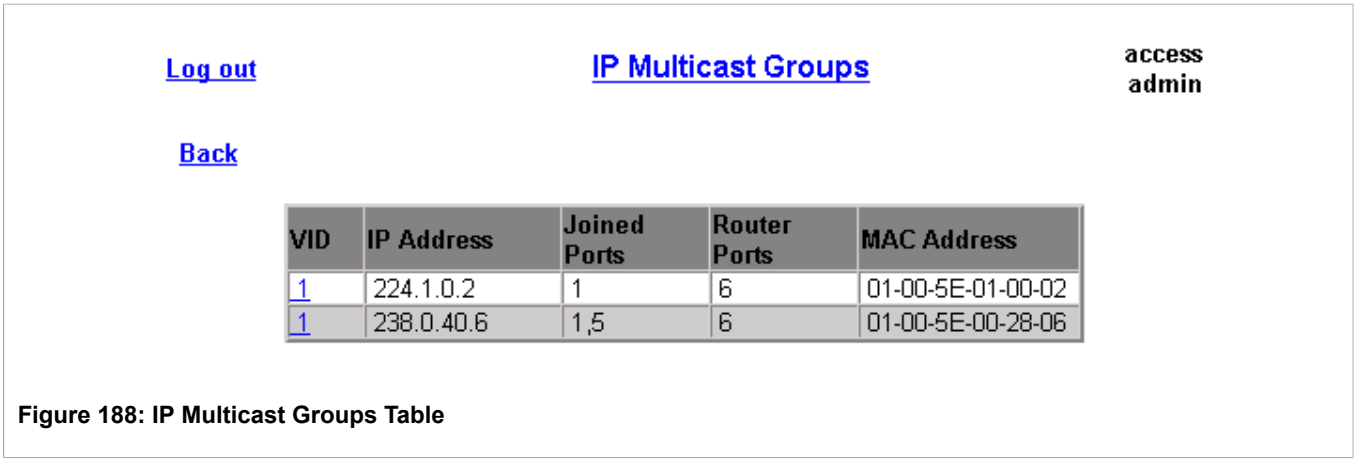


Figure 188: IP Multicast Groups Table

Parameter	Description
VID	**Synopsis:** 0 to 65535 The VLAN Identifier of the VLAN on which the multicast group operates.
IP Address	**Synopsis:** ###.###.###.### where ### ranges from 0 to 255 The multicast group IP address.
Joined Ports	**Synopsis:** Any combination of numbers valid for this parameter All ports that subscribed to the multicast group traffic.
Router Ports	**Synopsis:** Any combination of numbers valid for this parameter All ports that have been manually configured or dynamically discovered (by observing router specific traffic) as ports that link to multicast routers.
MAC Address	**Synopsis:** ##-##-##-##-##-## where ## ranges 0 to FF The multicast MAC address corresponding to the group multicast IP address.

Section 11.3.6
Multicast Group Summary

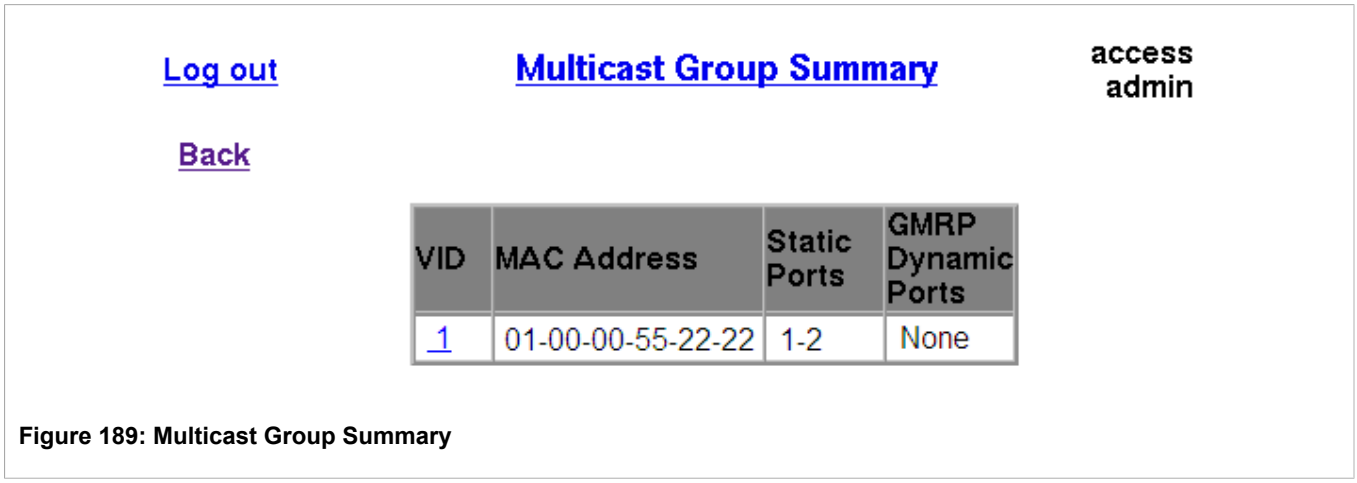


Figure 189: Multicast Group Summary

Parameter	Description
VID	**Synopsis:** 0 to 65535 The VLAN Identifier of the VLAN on which the multicast group operates.
MAC Address	**Synopsis:** ##-##-##-##-##-## where ## ranges 0 to FF The multicast group MAC address.
Static Ports	**Synopsis:** Any combination of numbers valid for this parameter Ports that joined this group statically through static configuration in Static MAC Table and to which the multicast group traffic is forwarded.
GMRP Dynamic Ports	**Synopsis:** Any combination of numbers valid for this parameter Ports that joined this group dynamically through GMRP Application and to which the multicast group traffic is forwarded.

Section 11.4
Troubleshooting

Problem One

When I start a multicast traffic feed, it is always distributed to all members of the VLAN.

Is IGMP enabled for the VLAN? Multicasts will be distributed to all members of the VLAN unless IGMP is enabled.

Problem Two

Computers on my switch receive the multicast traffic just fine, but I can't get the stream through a connected router.

Is the port used to connect the router included in the Router Ports list?

To determine whether the multicast stream is being delivered to the router, run the Ethernet Statistics menu *View Ethernet Statistics* command. Verify that the traffic count transmitted to the router is the same as the traffic count received from the multicasting source.

Problem Three

The video stream at one of my end stations is of pretty poor quality.

Video serving is a resource-intensive application. Because it uses isochronous workload, data must be fed at a prescribed rate or end users will see glitches in the video. Networks that carry data from the server to the client must be engineered to handle this heavy, isochronous workload.

Video streams can consume large amounts of bandwidth. Features and capacity of both server and network (including routers, bridges, switches, and interfaces) impact the streams.

You should not exceed 60% of the maximum interface bandwidth. For example, if using a 10 Mbps Ethernet, you should run a single multicasting source at no more than 6 Mbps, or two sources at 3 Mbps.

Router ports will carry the traffic of all multicast groups, so it is especially important to consider these ports in your design.

Note that multicasting will definitely introduce latency in all traffic on the network. Plan your network carefully in order to account for capacity and latency concerns.

Problem Four

Multicast streams of some groups are not forwarded properly. Some segments without subscribers receive the traffic while some segments with subscribers don't.

Ensure that you do not have a situation where different multicast groups have multicast IP addresses that map to the same multicast MAC address. The switch forwarding operation is MAC address-based and will not work properly for several groups mapping to the same MAC address.

Problem Five

Computers on my switch issue join requests but don't receive multicast streams from a router.

Is your multicast router running IGMP version 2? It must run IGMP version 2 in order for IGMP Snooping to operate properly.

Problem Six

I connect or disconnect some switch ports and multicast goes everywhere. Is IGMP broken?

No, it may be a proper switch behavior. When the switch detects a change in the network topology through STP, it acts to avoid loss of multicast traffic – if configured to do so, it starts forwarding all multicast traffic to all ports that are not STP Edge ports (because they may potentially link to routers). This may result in some undesired flooding of multicast traffic (which will stop after a few minutes), however, it guarantees that all devices interested in the traffic will keep receiving it without a break. Note that the same behavior will be observed when the switch resets or when IGMP Snooping is being enabled for the VLAN.

12 MAC Address Tables

ROS MAC address table management provides you with the following features:

- Viewing learned MAC addresses.
- Purging MAC Address Entries.
- Configuring the switch's MAC Address Aging time.
- Configuring static MAC addresses.
- Configuring flooding options.

The MAC Address Tables menu is accessible from the main menu.

Figure 190: MAC Address Tables Menu

Section 12.1
Viewing MAC Addresses

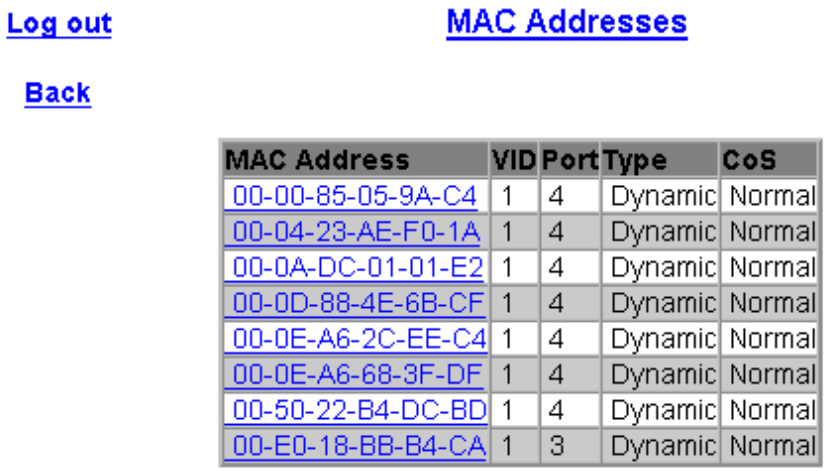

Log out
MAC Addresses
Back
MAC Address VID Port Type CoS
00-00-85-05-9A-C4 1 4 Dynamic Normal
00-04-23-AE-F0-1A 1 4 Dynamic Normal
00-0A-DC-01-01-E2 1 4 Dynamic Normal
00-0D-88-4E-6B-CF 1 4 Dynamic Normal
00-0E-A6-2C-EE-C4 1 4 Dynamic Normal
00-0E-A6-68-3F-DF 1 4 Dynamic Normal
00-50-22-B4-DC-BD 1 4 Dynamic Normal
00-E0-18-BB-B4-CA 1 3 Dynamic Normal

Figure 191: Address Table

Parameter	Description
MAC Address	**Synopsis:** ##-##-##-##-##-## where ## ranges 0 to FF A MAC address learned by the switch.
VID	**Synopsis:** 0 to 65535 The VLAN Identifier of the VLAN on which the MAC address operates.
Port	**Synopsis:** 0 to 65535 or { Multi, Local } The port on which MAC address has been learned. MULTI - multicast address, so there is no switch port associated with this MAC address.
Type	**Synopsis:** { Static, Dynamic } This describes how the MAC address has been learned by the switch: STATIC - the address has been learned as a result of a Static MAC Address Table configuration or some other management activity and can not be automatically unlearned or relearned by the switch. DYNAMIC - The address has been automatically learned by the switch and can be automatically unlearned.
CoS	Synopsis: { Normal, Medium, High, Crit } Specifies what Class Of Service is assigned to frames carrying this address as source or destination address.

Section 12.2

Configuring MAC Address Learning Options

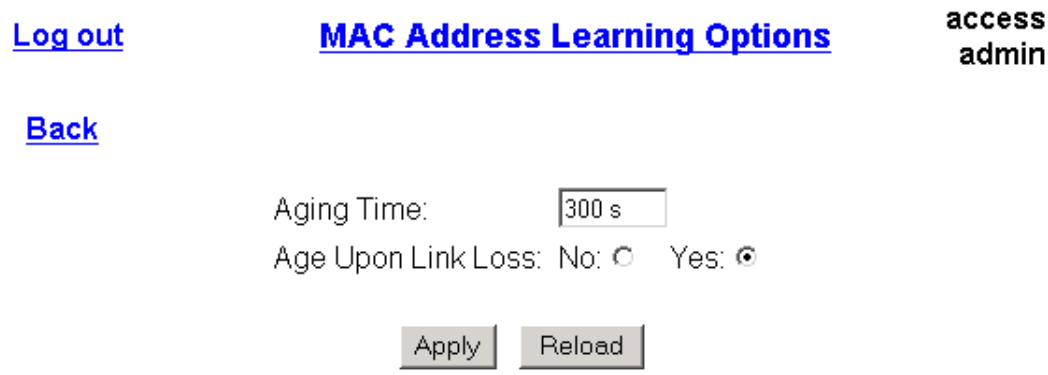


Figure 192: MAC Address Learning Options Form

Parameter	Description
Aging Time	**Synopsis:** 15 to 800 **Default:** 300 s This parameter configures the time that a learned MAC address is held before being aged out.
Age Upon Link Loss	**Synopsis:** { No, Yes } **Default:** Yes When a link failure (and potentially a topology change) occurs, the switch may have some MAC addresses previously learned on the failed port. As long as those addresses are not aged out, the switch will still be forwarding traffic to that port, thus preventing that traffic from reaching its destination via the new network topology. This parameter allows the aging out of all MAC addresses learned on a failed port immediately upon link failure detection.

Section 12.3
Configuring Flooding Options

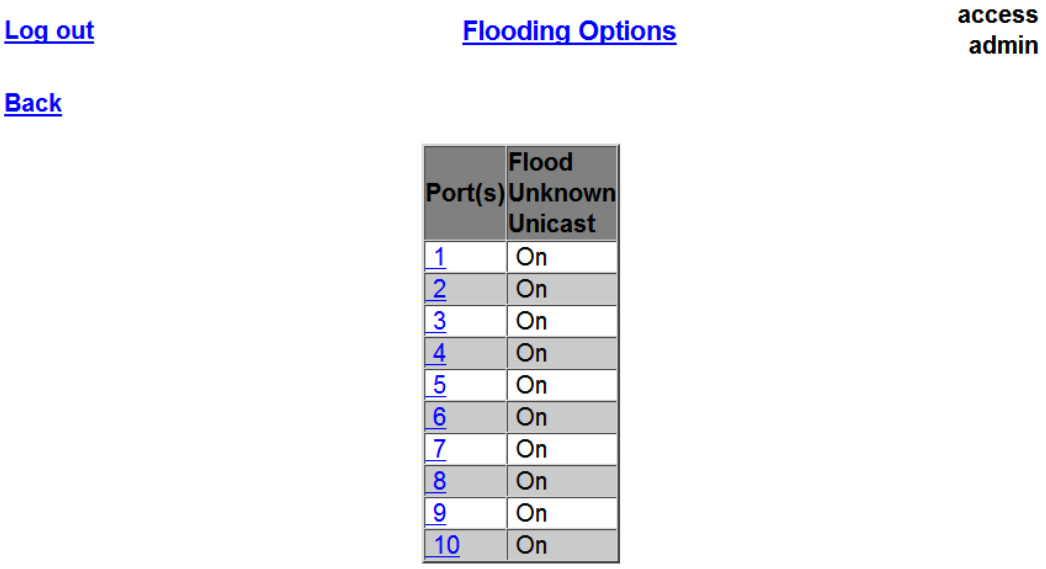


Figure 193: MAC Address Flooding Options Table

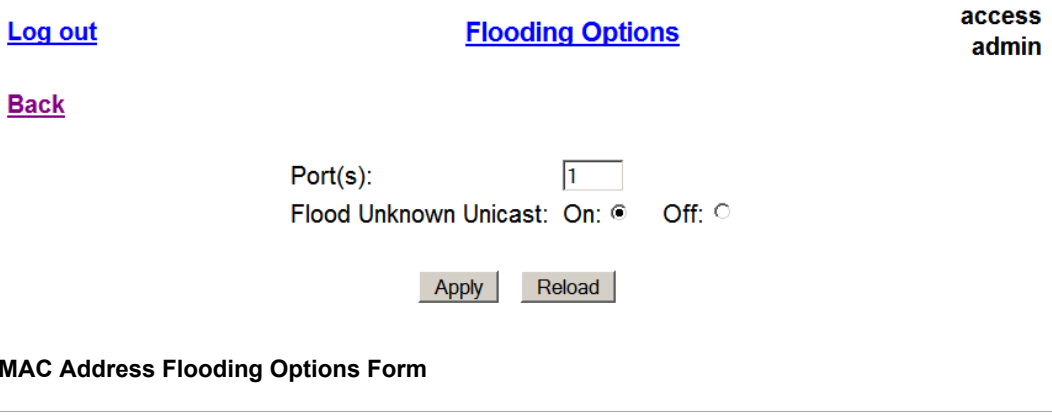


Figure 194: MAC Address Flooding Options Form

Parameter	Description
Port(s)	**Synopsis:** Any combination of numbers valid for this parameter The port number as seen on the front plate silkscreen of the switch (or a list of ports, if aggregated in a port trunk).
Flood Unknown Unicast	**Synopsis:** { On, Off } **Default:** On Normally, unicast traffic with an unknown destination address is flooded out of all ports. When a port is configured to turn off this kind of flooding, the unknown unicast traffic is not sent out from the selected port.

Section 12.4

Configuring Static MAC Address Table

Static MAC addresses are usually configured when the user wishes to enforce port security (if supported).

Static MAC addresses are also configured when a device can receive but cannot transmit frames.

Prioritized MAC addresses are configured when traffic to or from a specific device on a LAN segment is to be assigned a higher CoS priority than other devices on that LAN segment.

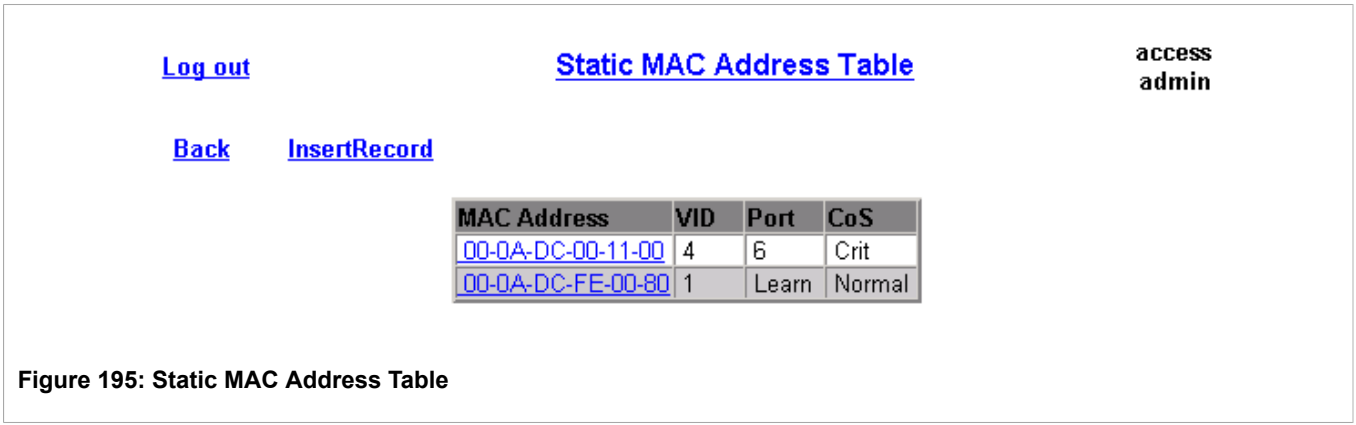


Figure 195: Static MAC Address Table

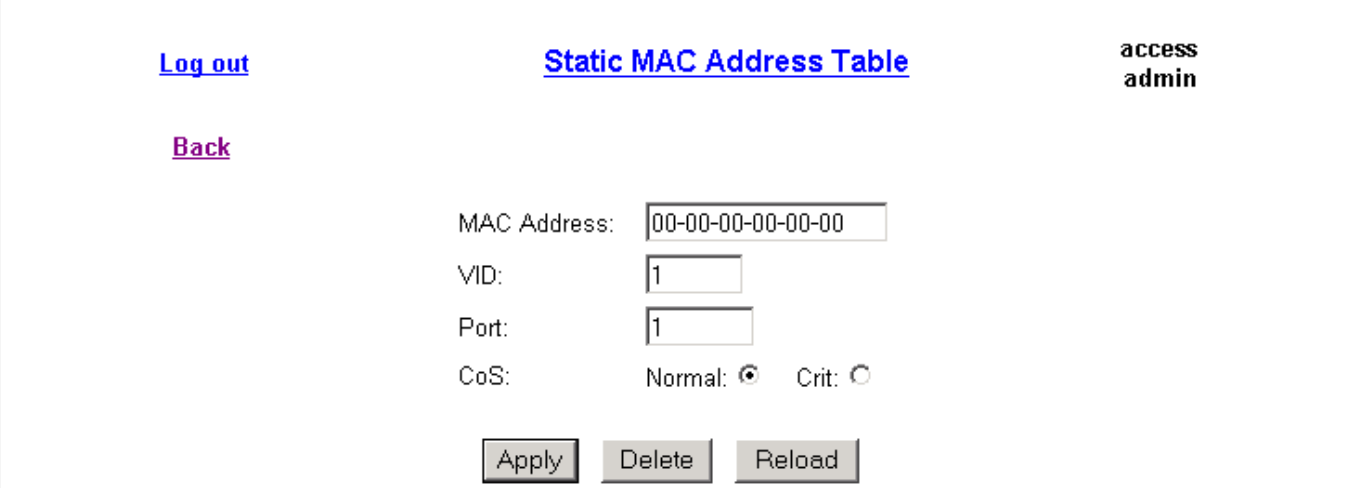


Figure 196: Static MAC Address Form

Parameter	Description
MAC Address	**Synopsis:** ##-##-##-XX-XX-XX, where ## is 0 to FF, XX is 0 to FF or * wildcard **Default:** 00-00-00-00-00-00 A MAC address that is to be statically configured. A maximum of 6 wildcard characters may be used to specify a range of MAC addresses allowed to be learned by the Port Security module (when Port Security is set to 'Static MAC' mode). Wildcards must start from the end of the MAC address and all wildcards must be contiguous. Examples: • 00-0A-DC-**-**-** means the range beginning with 00-0A-DC-00-00-00 and ending with 00-0A-DC-FF-FF-FF.

Parameter	Description
	• 00-0A-DC-12-3*-** means the range beginning with 00-0A-DC-12-30-00 and ending with 00-0A-DC-12-3F-FF
VID	**Synopsis:** 1 to 4094 **Default:** 1 The VLAN Identifier of the VLAN on which the MAC address operates.
Port	Synopsis: 1 to maximum port number or { Learn } Default: Learn Enter the port number upon which the device with this address is located. If the port should be auto-learned, set this parameter to 'Learn'.
CoS	Synopsis: { Normal, Medium, High, Crit } **Default:** Normal Set this parameter to prioritize the traffic for a specified address.

Section 12.5
Purging MAC Address Table

This command removes all dynamic entries from the MAC address table. The only negative impact of this operation is that it causes flooding while addresses are relearned.

13 Network Discovery

ROS supports two different Layer 2 protocols for automated network discovery: LLDP, (the Link Layer Discovery Protocol)and RCDP (the RUGGEDCOM Discovery Protocol™).

LLDP is an IEEE standard protocol, IEEE 802.1AB, which allows a networked device to advertise its own basic networking capabilities and configuration. ROS is capable of advertising and collecting network information via LLDP. LLDP functionality in ROS includes the ability to:

- Enable or disable LLDP reception and transmission per port or for the whole device
- View LLDP statistics
- View 'neighbor' information
- Report LLDP neighbor information via SNMP

RCDP™ (the RUGGEDCOM Discovery Protocol™) is designed primarily for the initial deployment of RUGGEDCOM networking devices that have not been configured. In response to RCDP commands and queries from an application such as RUGGEDCOM Explorer, which supports RCDP, ROS has the ability to:

- Enable or disable RCDP functionality
- Report its basic network configuration and other identifying information
- Respond to a basic set of control commands
- Perform basic device configuration

Section 13.1

LLDP Operation

The IEEE standard, 802.1AB Link Layer Discovery Protocol (LLDP), describes a protocol that can simplify the troubleshooting of complex networks and can be used by Network Management Systems (NMS) to obtain and monitor detailed information about a network's topology. LLDP data are made available via SNMP (through support of LLDP-MIB).

LLDP allows a networked device to discover its neighbors across connected network links using a standard mechanism. Devices that support LLDP are able to advertise information about themselves, including their capabilities, configuration, interconnections, and identifying information.

LLDP agent operation is typically implemented as two modules: the LLDP transmit module and LLDP receive module. The LLDP transmit module, when enabled, sends the local device's information at regular intervals, in 802.1AB standard format. Whenever the transmit module is disabled, it transmits an LLDPDU (LLDP data unit) with a time-to-live (TTL) time length value (TLV) containing "0" in the information field. This enables remote devices to remove the information associated with the local device in their databases. The LLDP receive module, when enabled, receives remote devices’ information and updates its LLDP database of remote systems. When new or updated information is received, the receive module initiates a timer for the valid duration indicated by the TTL TLV in the received LLDPDU. A remote system's information is removed from the database when an LLDPDU is received from it with TTL TLV containing "0" in its information field.

NOTE
LLDP is implemented to keep a record of only one device per Ethernet port. Therefore, if there are multiple devices sending LLDP information to a switch port on which LLDP is enabled, information about the neighbor on that port will change constantly.

CAUTION!
LLDP is not secure by definition. Avoid enabling LLDP on devices connected to external networks. Siemens recommends using LLDP only in secure environments operating within a security perimeter.

Section 13.2
RCDP Operation

The purpose of the RUGGEDCOM Discovery Protocol™ is to support the deployment of ROS-based devices that have not been configured since leaving the factory. ROS devices that have not been configured all have the default IP (Layer 3) address. Connecting more than one of them on a Layer 2 network means that one cannot use standard IP-based configuration tools to configure them. The behavior of IP-based mechanisms such as the web interface, SSH, telnet, or SNMP will all be undefined.

Since RCDP operates at Layer 2, it can be used to reliably and unambiguously address multiple devices even though they may share the same IP configuration.

Siemens's RUGGEDCOM Explorer is a lightweight, standalone Windows application that supports RCDP. It is capable of discovering, identifying and performing basic configuration of ROS-based devices via RCDP. The features supported by RCDP include:

- Discovery of ROS-based devices over a Layer 2 network.
- Retrieval of basic network configuration, ROS version, order code, and serial number.
- Control of device LEDs for easy physical identification.
- Configuration of basic identification, networking, and authentication parameters.

For security reasons, RUGGEDCOM Explorer will attempt to disable RCDP on all devices when Explorer is shut down. If RUGGEDCOM Explorer is unable to disable RCDP on a device, ROS will automatically disable RCDP after approximately one hour of inactivity.

NOTE
RCDP is not compatible with VLAN-based network configurations. For correct operation of RUGGEDCOM Explorer, no VLANs (tagged or untagged) must be configured. All VLAN configuration items must be at their default settings.

NOTE
ROS responds to RCDP requests only. It does not under any circumstances initiate any RCDP-based communication.

Section 13.3
Network Discovery Menu

The main Network Discovery menu links to configuration menus for both LLDP and RCDP.

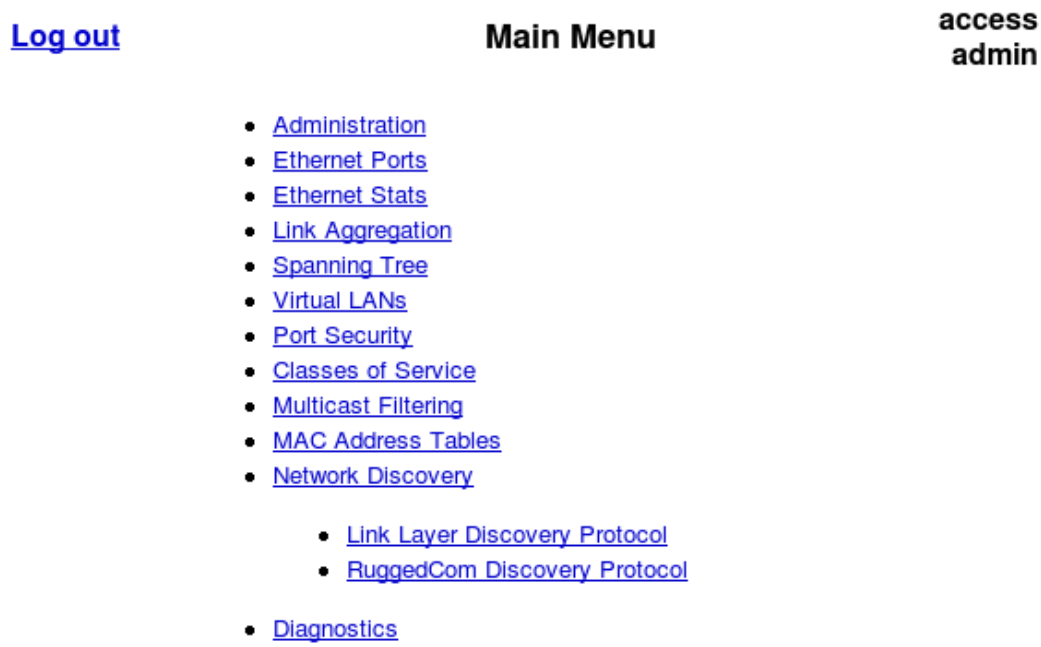


Figure 197: Network Discovery Main Menu

Section 13.3.1

LLDP Menu

The LLDP menu is used to configure LLDP on the switch, globally and per port, to exchange LLDP information with neighbors, and to view LLDP information and statistics.

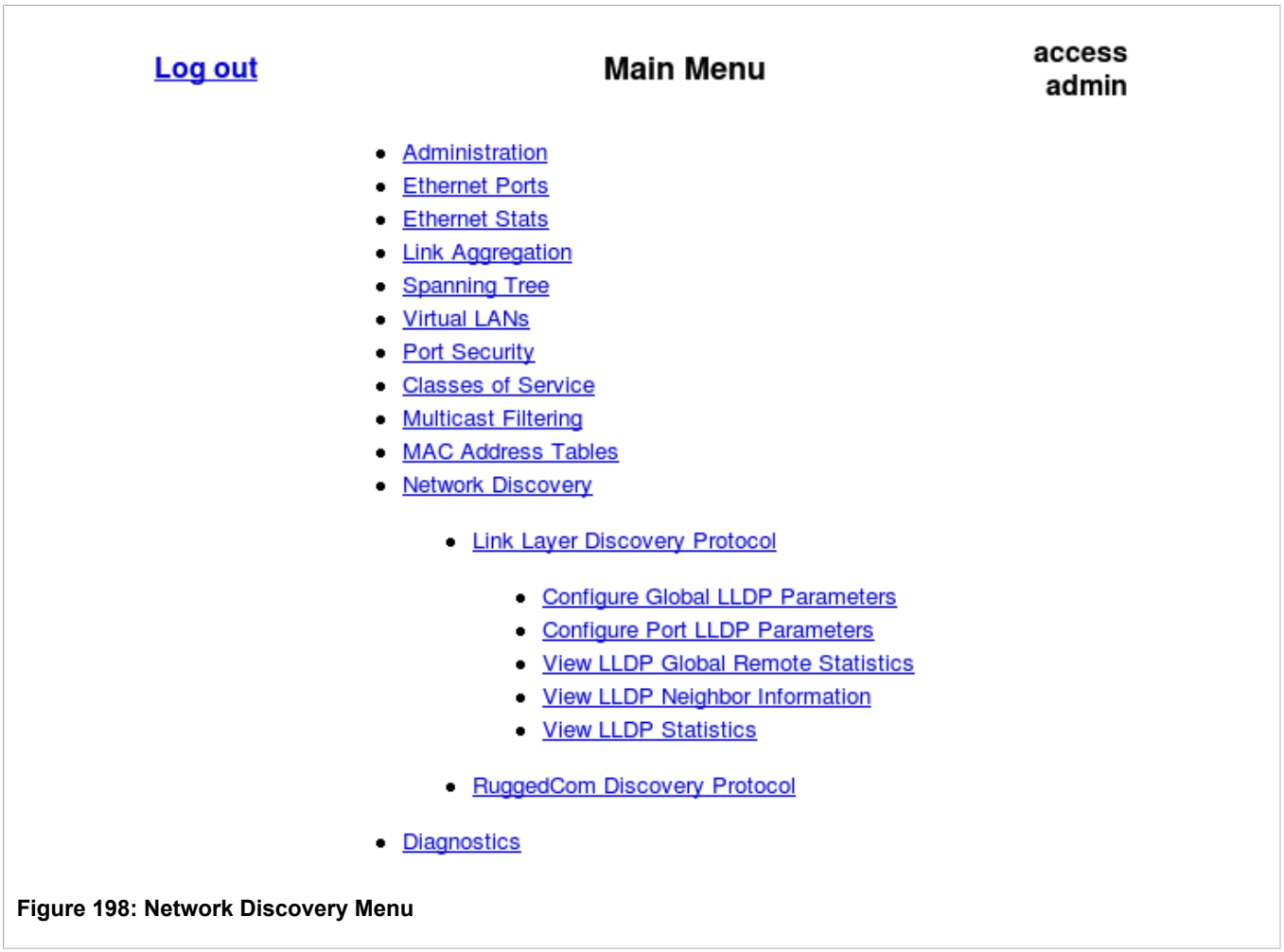


Figure 198: Network Discovery Menu

Section 13.3.1.1
Global LLDP Parameters

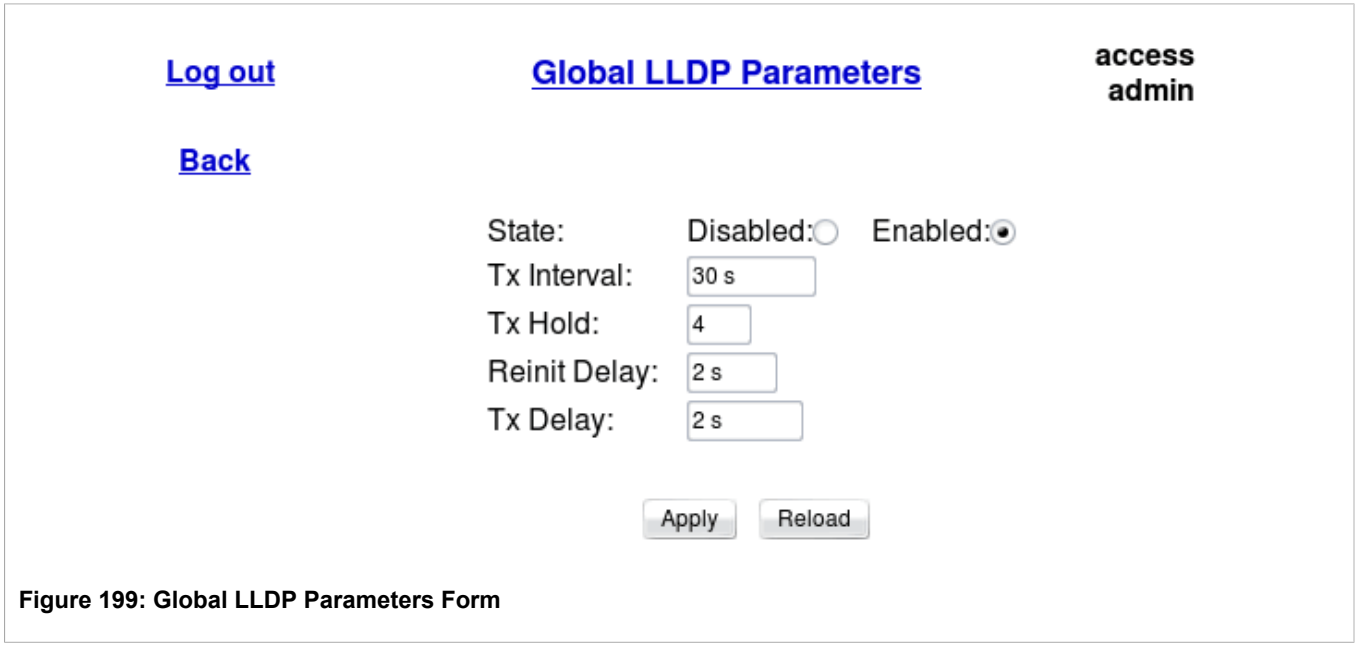


Figure 199: Global LLDP Parameters Form

Parameter	Description
State	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Enables the LLDP protocol. Note that LLDP is enabled on a port when LLDP is enabled globally and along with enabling per port setting in Port LLDP Parameters menu.
Tx Interval	**Synopsis:** 5 to 32768 **Default:** 30 s The interval at which LLDP frames are transmitted on behalf of this LLDP agent.
Tx Hold	**Synopsis:** 2 to 10 **Default:** 4 The multiplier of the Tx Interval parameter that determines the actual time-to-live (TTL) value used in a LLDPDU. The actual TTL value can be expressed by the following formula: TTL = MIN(65535, (Tx Interval * Tx Hold))
Reinit Delay	**Synopsis:** 1 to 10 **Default:** 2 s The delay in seconds from when the value of Admin Status parameter of a particular port becomes 'Disabled' until re-initialization will be attempted.
Tx Delay	**Synopsis:** 1 to 8192 **Default:** 2 s The delay in seconds between successive LLDP frame transmissions initiated by value or status changed. The recommended value is set according to the following formula: 1 <= txDelay <= (0.25 * Tx Interval)

Section 13.3.1.2
Port LLDP Parameters

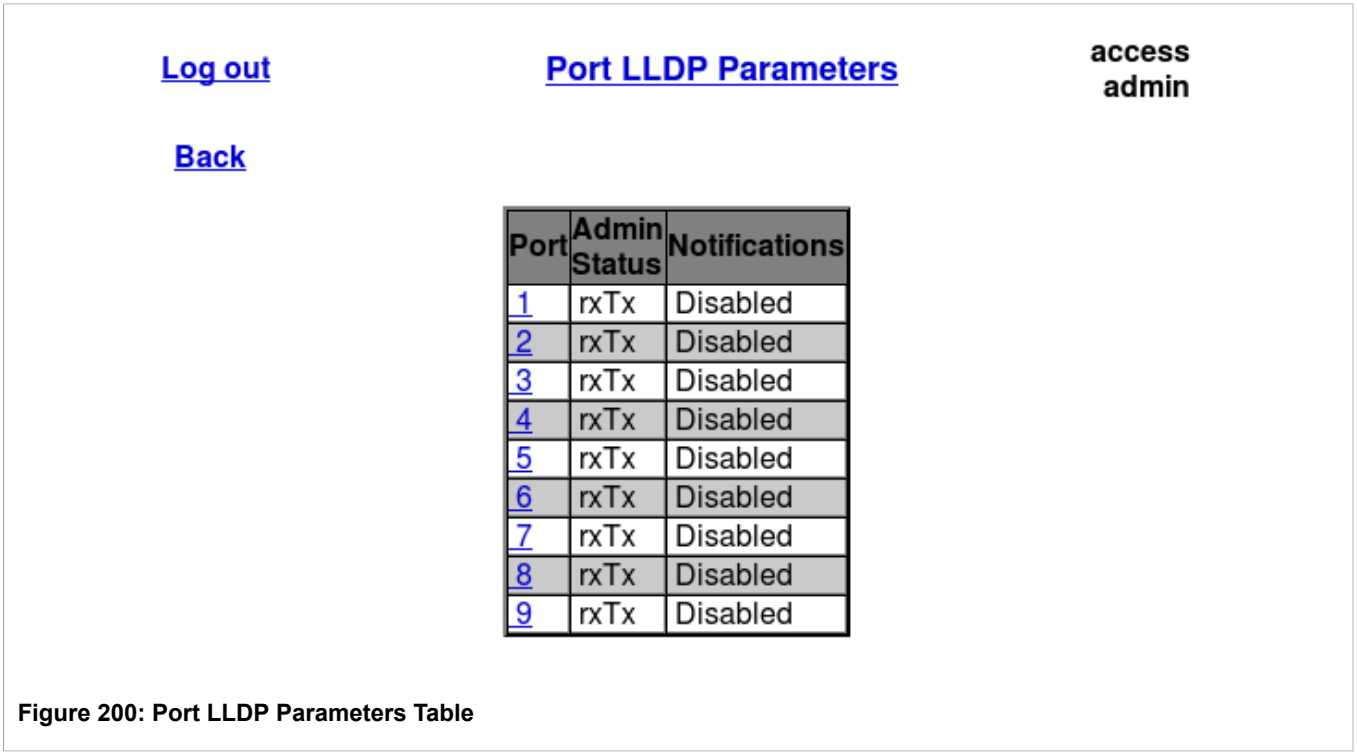


Figure 200: Port LLDP Parameters Table

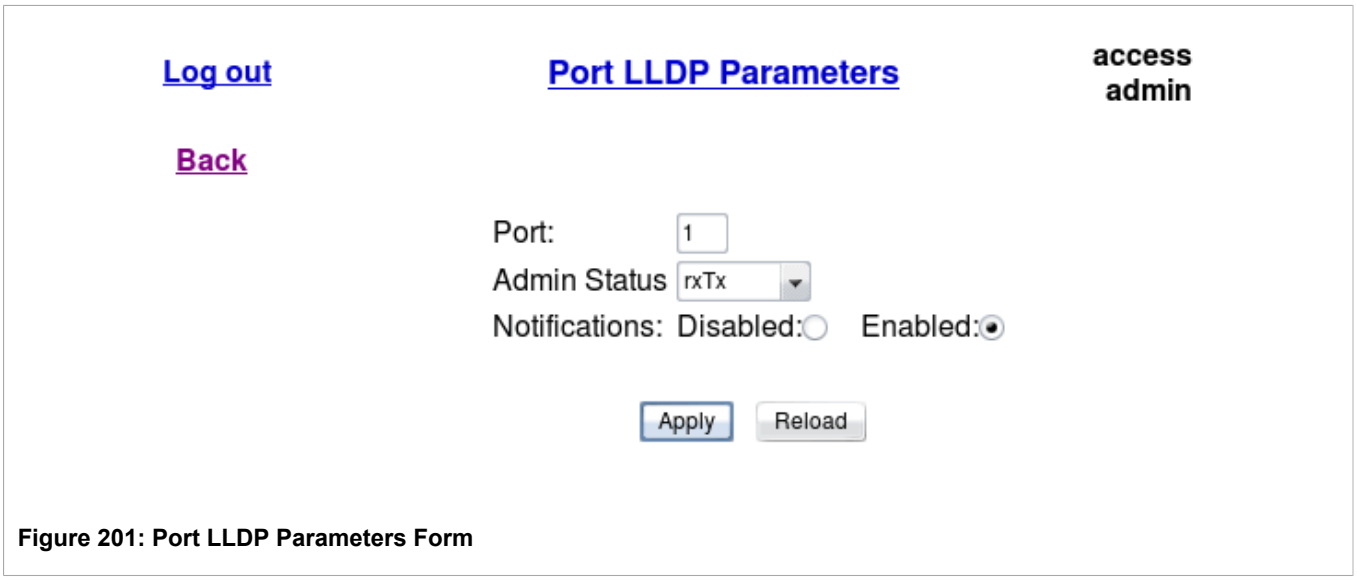


Figure 201: Port LLDP Parameters Form

Parameter	Description
Port	**Synopsis:** 1 to 9 **Default:** 1 The port number as seen on the front plate silkscreen of the switch.
Admin Status	**Synopsis:** { rxTx, txOnly, rxOnly, Disabled } **Default:** rxTx • rxTx: the local LLDP agent can both transmit and receive LLDP frames through the port.

Parameter	Description
	• txOnly: the local LLDP agent can only transmit LLDP frames. • rxOnly: the local LLDP agent can only receive LLDP frames. • disabled: the local LLDP agent can neither transmit nor receive LLDP frames.
Notifications	**Synopsis:** { Disabled, Enabled } **Default:** Disabled Enabling notifications will allow the LLDP agent to send notifications and generate alarms for the port.

Section 13.3.1.3
LLDP Global Remote Statistics

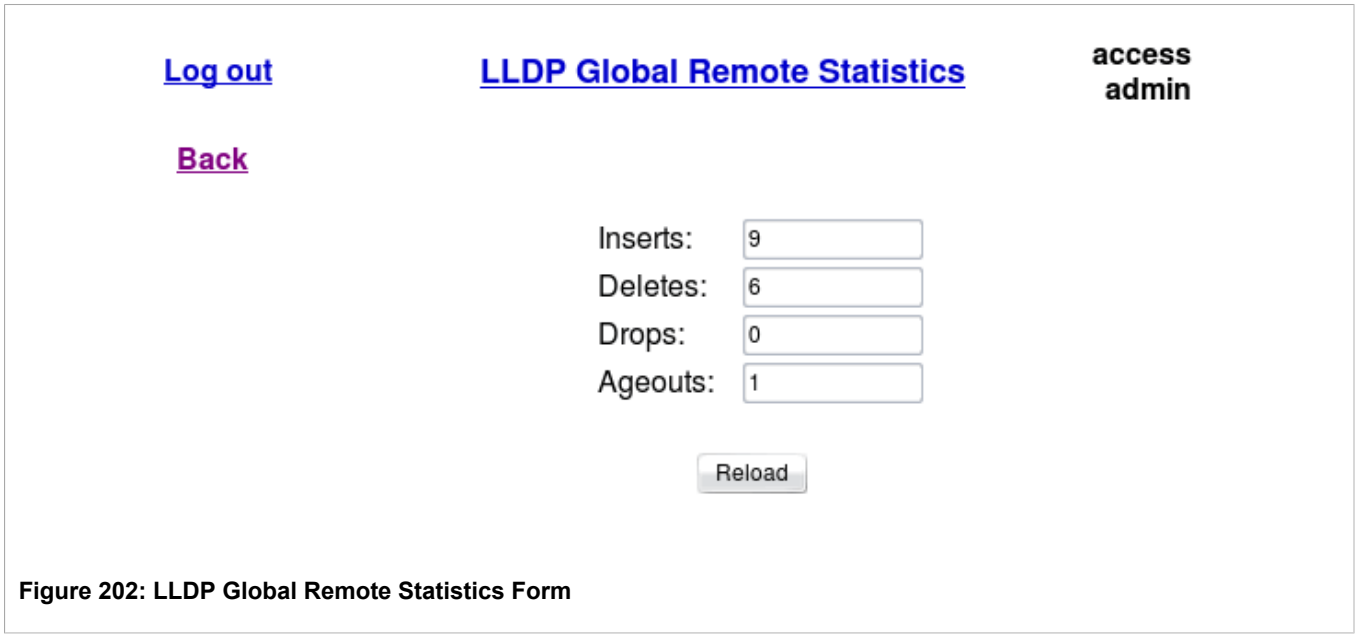


Figure 202: LLDP Global Remote Statistics Form

Parameter	Description
Inserts	**Synopsis:** 0 to 4294967295 The number of times an entry was inserted into the LLDP Neighbor Information Table.
Deletes	**Synopsis:** 0 to 4294967295 The number of times an entry was deleted from the LLDP Neighbor Information Table.
Drops	**Synopsis:** 0 to 4294967295 The number of times an entry was deleted from the LLDP Neighbor Information Table because the information timeliness interval has expired.
Ageouts	**Synopsis:** 0 to 4294967295 The number of all TLVs discarded.

Section 13.3.1.4
LLDP Neighbor Information

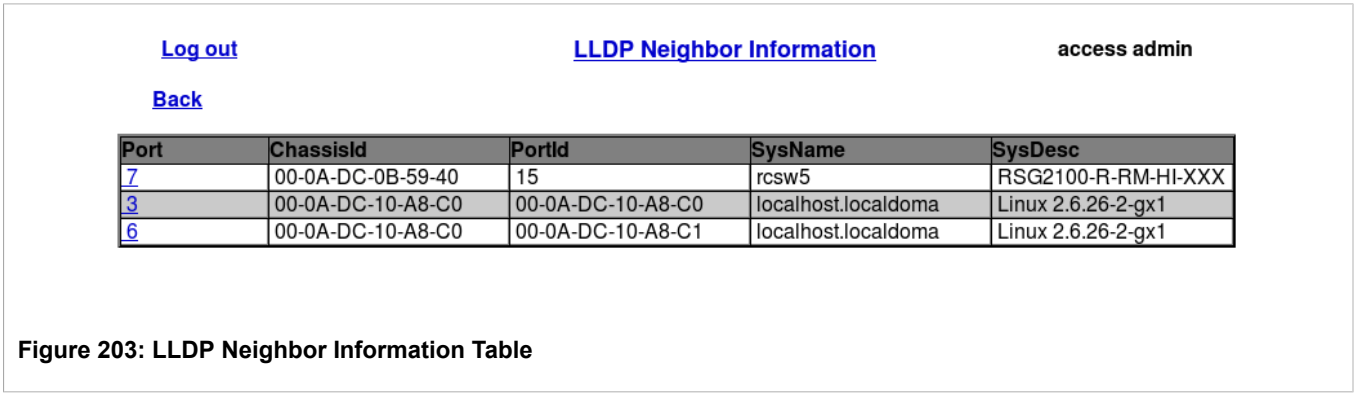
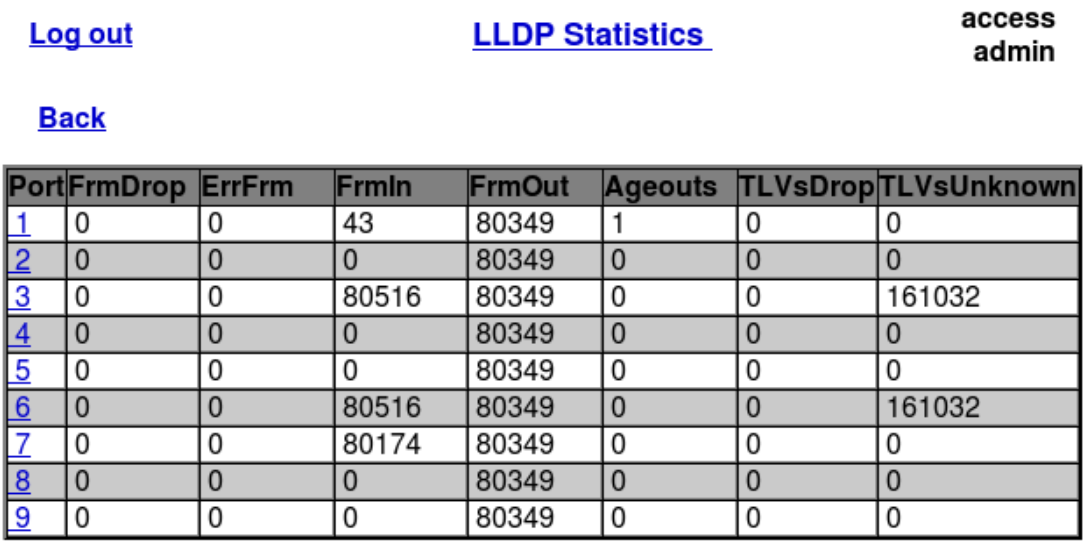


Figure 203: LLDP Neighbor Information Table

Parameter	Description
Port	**Synopsis:** 0 to 4294967295 The local port associated with this entry.
ChassisId	**Synopsis:** Any 19 characters Chassis Id information received from a remote LLDP agent.
PortId	**Synopsis:** Any 19 characters Port Id information received from a remote LLDP agent.
SysName	**Synopsis:** Any 19 characters System Name information received from a remote LLDP agent.
SysDesc	**Synopsis:** Any 19 characters System Descriptor information received from a remote LLDP agent.

Section 13.3.1.5
LLDP Statistics



Port	FrmDrop	ErrFrm	FrmIn	FrmOut	Ageouts	TLVsDrop	TLVsUnknown
1	0	0	43	80349	1	0	0
2	0	0	0	80349	0	0	0
3	0	0	80516	80349	0	0	161032
4	0	0	0	80349	0	0	0
5	0	0	0	80349	0	0	0
6	0	0	80516	80349	0	0	161032
7	0	0	80174	80349	0	0	0
8	0	0	0	80349	0	0	0
9	0	0	0	80349	0	0	0

Figure 204: LLDP Statistics Table

Parameter	Description
Port	**Synopsis:** 1 to 9 The port number as seen on the front plate silkscreen of the switch.
FrmDrop	**Synopsis:** 0 to 4294967295 The number of all LLDP frames discarded.
ErrFrm	**Synopsis:** 0 to 4294967295 The number of all LLDPDUs received with detectable errors.
FrmIn	**Synopsis:** 0 to 4294967295 The number of all LLDPDUs received.
FrmOut	**Synopsis:** 0 to 4294967295 The number of all LLDPDUs transmitted.
Ageouts	**Synopsis:** 0 to 4294967295 The number of times that a neighbor's information has been deleted from the LLDP remote system MIB because the txinfoTTL timer has expired.
TLVsDrop	**Synopsis:** 0 to 4294967295 The number of all TLVs discarded.
TLVsUnknown	**Synopsis:** 0 to 4294967295 The number of all TLVs received on the port that are not recognized by the LLDP local agent.

Section 13.3.2

RCDP Configuration

Figure 205: RCDP Parameters Form

Parameter	Description
RCDP Discovery	**Synopsis:** { Disabled, Enabled } **Default:** Enabled Disables/Enables Device Discovery through Siemens Proprietary RCDP.

14 Diagnostics

ROS provides the following diagnostics features:

- Alarm System to view and clear alarms
- Viewing and clearing the system log
- Viewing CPU diagnostics
- Viewing the product information
- Loading the factory default configuration
- Resetting the device
- Transferring Files

The Diagnostics menu is accessible from the main menu:

Figure 206: Diagnostics Menu

Section 14.1

Using the Alarm System

Alarms are the occurrence of events of interest that are logged by the device. If alarms have occurred, the device will indicate the number of alarms in the top right corner of all menu screens.

There are two broad types of alarms - active and passive alarms.

Section 14.1.1
Active Alarms

Active alarms are ongoing. They signify states of operation that are not in accordance with normal operation. Examples of active alarms include links that should be up but are not or error rates that are continuously exceeding a certain threshold.

Active alarms are removed (cleared) either by solving the original cause of the alarm or by explicitly clearing the alarm itself.

Section 14.1.2
Passive Alarms

Passive alarms are historic in nature. They signify events that represented abnormal conditions in the past, and do not affect the current operational status. Examples of passive alarms include authentication failures or error rates that temporarily exceeded a certain threshold.

Passive alarms are cleared through the Clear Alarms option under the diagnostics menu. RMON generated alarms are passive.

Section 14.1.3
Alarms and the Critical Failure Relay

All active alarms will immediately de-energize the critical fail relay (thus signifying a problem). The relay will be re-energized when the last outstanding active alarm is cleared.

NOTE
Alarms are volatile in nature. All alarms (active and passive) are cleared at startup.

Section 14.1.4
Configuring Alarms

ROS provides a means for selectively configuring alarms in fine-grained detail. Some notes on alarm configuration in ROS:

- Alarms at levels CRITICAL or ALERT are not configurable nor can they be disabled.
- The "Level" field is read-only; the preconfigured alarm level is not a configurable option.
- Alarms cannot be added to or deleted from the system.
- Alarm configuration settings changed by a user will be saved in the configuration file.
- The "alarms" CLI command lists all alarms - configurable and non-configurable.

Log out Alarms 3 Alarms!

Back InsertRecord

Name	Level	Latch	Trap	Log	LED&Relay	Refresh Time
BPDU Guard activated	ERRO	On	On	On	On	60 s
Boot version mismatch	WARN	On	On	On	On	0 s
Can't create more mcast IP groups	WARN	On	On	On	On	60 s
Clock manager alarm	WARN	On	On	On	On	60 s
Configuration changed	INFO	Off	On	On	Off	60 s
Default keys in use	WARN	On	On	On	On	0 s
Excessive failed login attempts	WARN	On	On	On	On	60 s
GMRP cannot learn more addresses	WARN	On	On	On	On	1 s
GPS alarm	WARN	On	On	On	On	60 s
GVRP cannot learn more VLANs	WARN	On	On	On	On	1 s
IEEE1588 alarm	WARN	On	On	On	On	60 s
IRIGB alarm	WARN	On	On	On	On	60 s
Inconsistent speed/dpx in trunk	ERRO	On	On	On	On	1 s
Invalid configuration	ERRO	On	On	Off	On	60 s
Link up/down	WARN	On	On	On	On	1 s
Login information	INFO	Off	On	On	Off	0 s
MAC address authorization failed	ERRO	On	On	On	On	0 s
MAC address not learned	WARN	On	On	On	On	0 s
Mcast CPU filtering table full	WARN	On	On	On	On	60 s
NTP server unreachable	WARN	On	On	On	On	0 s
New STP root	INFO	Off	Off	Off	Off	0 s
Port security violated	WARN	On	On	On	On	0 s
Power supply failed	WARN	On	On	On	On	60 s
RADIUS server unreachable	WARN	On	On	On	On	0 s
Received looped back BPDU	ERRO	On	On	On	On	60 s
SNMP authentication failed	WARN	On	On	On	Off	60 s
STP events	INFO	Off	Off	On	Off	0 s
STP topology change	INFO	Off	Off	Off	Off	0 s
TACACS response invalid	WARN	On	On	On	On	1 s
TACACS server unreachable	WARN	On	On	On	On	0 s
Unknown privKey from SNMPv3 user	WARN	On	On	On	On	60 s
Weak password configured	WARN	On	On	Off	Off	60 s

Figure 207: Alarm Configuration Table

Log out Alarms access admin

Back

Name: Excessive failed login attempts
Level: WARN
Latch: On: Off:
Trap: On: Off:
Log: On: Off:
LED&Relay: On: Off:
Refresh Time: 60 s

Apply Delete Reload

Figure 208: Alarm Configuration Form

Parameter	Description
Name	**Synopsis:** Any 34 characters **Default:** sys_alarm The alarm name (e.g. as obtained via CLI:"alarms")
Level	**Synopsis:** { EMRG, ALRT, CRIT, ERRO, WARN, NOTE, INFO, DEBG } Severity level of the alarm: • EMERG - The device has had a serious failure that caused a system reboot. • ALERT - The device has had a serious failure that did not cause a system reboot. • CRITICAL - The device has a serious unrecoverable problem. • ERROR - The device has a recoverable problem that does not seriously affect operation. • WARNING - Possibly serious problem affecting overall system operation. • NOTIFY - Condition detected that is not expected or not allowed. • INFO - Event which is a part of normal operation, e.g. cold start, user login etc. • DEBUG - Intended for factory troubleshooting only.
Latch	**Synopsis:** { On, Off } **Default:** Off Enables latching occurrence of this alarm in the Alarms Table.
Trap	**Synopsis:** { On, Off } **Default:** Off Enables sending an SNMP trap for this alarm.
Log	**Synopsis:** { On, Off } **Default:** Off Enables logging the occurrence of this alarm in syslog.txt.
LED & Relay	**Synopsis:** { On, Off } **Default:** Off Enables LED and fail-safe relay control for this alarm. If latching is not enabled, this field will remain disabled.
Refresh Time	**Synopsis:** 0 s to 60 s **Default:** 60 s Refreshing time for this alarm.

Section 14.1.5
Viewing and Clearing Alarms

Alarms are displayed in the order in which they occurred, even if the real time clock was incorrect at the time of the alarm.

Figure 209: Alarm Table

Parameter	Description
Level	**Synopsis:** { EMRG, ALRT, CRIT, ERRO, WARN, NOTE, INFO, DEBG } Severity level of the alarm: • EMERG - The device has had a serious failure that caused a system reboot. • ALERT - The device has had a serious failure that did not cause a system reboot. • CRITICAL - The device has a serious unrecoverable problem. • ERROR - The device has a recoverable problem that does not seriously affect operation. • WARNING - Possibly serious problem affecting overall system operation. • NOTIFY - Condition detected that is not expected or not allowed. • INFO - Event which is a part of normal operation, e.g. cold start, user login etc. • DEBUG - Intended for factory troubleshooting only.
Time	**Synopsis:** MMM DD HH:MM Time of first occurrence of the alarm.
Description	**Synopsis:** Any 127 characters Description of the alarm; gives details about the frequency of the alarm if it has occurred again since the last clear.

Alarms can be cleared from the Clear Alarms option.

Section 14.1.6
Security Messages for Authentication

The following describes the authentication-related security messages that can be generated by ROS.

Section 14.1.6.1
Security Messages for Login Authentication

ROS provides various logging options related to login authentication. A user can log into a ROS device in three different ways: Console, SSH or Telnet. ROS can log messages in the syslog, send a trap to notify an SNMP manager, and/or raise an alarm when a successful and unsuccessful login event occurs. In addition, when a weak password is configured on a unit or when the primary authentication server for TACACS+ or RADIUS is not reachable, ROS will raise alarms, send SNMP traps and log messages in the syslog.

The following is a list of log and alarm messages related to user authentication:

- Weak Password Configured
- Default Keys In Use
- Login and Logout Information
- Excessive Failed Login Attempts
- RADIUS Server Unreachable
- TACACS Server Unreachable
- TACACS Response Invalid
- SNMP Authentication Failure
- Unknown privKey from SNMPv3 User

NOTE
All alarms and log messages related to login authentication are configurable. See Section 14.1.4, "Configuring Alarms" for more information.

Weak Password Configured

ROS generates this alarm and logs a message in the syslog when a weak password is configured in the Passwords table.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
Weak Password Configured	Yes	Yes	Yes

Default Keys In Use

ROS generates this alarm and logs a message in the syslog when default keys are in use. For more information about default keys, refer to Section 15.8, "Certificate and Key Management".

NOTE
For Non-Controlled (NC) versions of ROS, this alarm is only generated when default SSL keys are in use.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
Default Keys In Use	Yes	Yes	Yes

Login and Logout Information

ROS generates this alarm and logs a message in the syslog when a successful and unsuccessful login attempt occurs. A message is also logged in the syslog when a user with a certain privilege level is logged out from the device.

Login attempts are logged regardless of how the user accesses the device (i.e. SSH, Web, Console, Telnet or RSH). However, when a user logs out, a message is only logged when the user is accessing the device through SSH, Telnet or Console.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
Successful Login	Yes	Yes	Yes

Message Name	Alarm	SNMP Trap	Syslog
Failed Login	Yes	Yes	Yes
User Logout	No	No	Yes

Excessive Failed Login Attempts

ROS generates this alarm and logs a message in the syslog after 10 failed login attempts by a user.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
Excessive Failed Login Attempts	Yes	Yes	Yes

RADIUS Server Unreachable

ROS generates this alarm and logs a message in the syslog when the primary RADIUS server is unreachable.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
Primary RADIUS Server Unreachable	Yes	Yes	Yes

TACACS Server Unreachable

ROS generates this alarm and logs a message in the syslog when the primary TACACS server is unreachable.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
Primary TACACS Server Unreachable	Yes	Yes	Yes

TACACS Response Invalid

ROS generate this alarm and logs a message in the syslog when the response from the TACACS server is received with an invalid CRC.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
TACACS Response Invalid	Yes	Yes	Yes

SNMP Authentication Failure

ROS generates this alarm, sends an authentication failure trap, and logs a message in the syslog when an SNMP manager with incorrect credentials communicates with the SNMP agent in ROS.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
SNMP Authentication Failure	Yes	Yes	Yes

Section 14.1.6.2
Security Messages for Port Authentication

NOTE
The port security feature is not available on all platforms. This section is only applicable for the platforms that can support the port security feature.

The following is the list of log and alarm messages related to port access control in ROS:

- MAC Address Authorization Failure
- Secure Port X Learned MAC Addr on VLAN X
- Port Security Violated

MAC Address Authorization Failure

ROS generates this alarm and logs a message in the syslog when a host connected to a secure port on the device is communicating using a source MAC address which has not been authorized by ROS, or the dynamically learned MAC address has exceeded the total number of MAC addresses configured to be learned dynamically on the secured port. This message is only applicable when the port security mode is set to "Static MAC".

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
MAC Address Authorization Failure	Yes	Yes	Yes

Secure Port X Learned MAC Addr on VLAN X

ROS logs a message in the syslog and sends a configuration change trap when a MAC address is learned on a secure port. Port X indicates the secured port number and VLAN number on that port. This message is not configurable in ROS.

Table: Message Details

Message Name	SNMP Trap	Syslog
Secure Port X Learned MAC Addr on VLAN X	Yes	Yes

Port Security Violated

This message is only applicable when the security mode for a port is set to "802.1x or 802.1x/MAC-Auth"

ROS this alarm and logs a message in the syslog when the host connected to a secure port tries to communicate using incorrect login credentials.

Table: Configurable Options

Message Name	Alarm	SNMP Trap	Syslog
802.1x Port X Authentication Failure	Yes	Yes	Yes
802.1x Port X Authorized Addr. XXX	No	No	Yes

Section 14.2

Viewing CPU Diagnostics

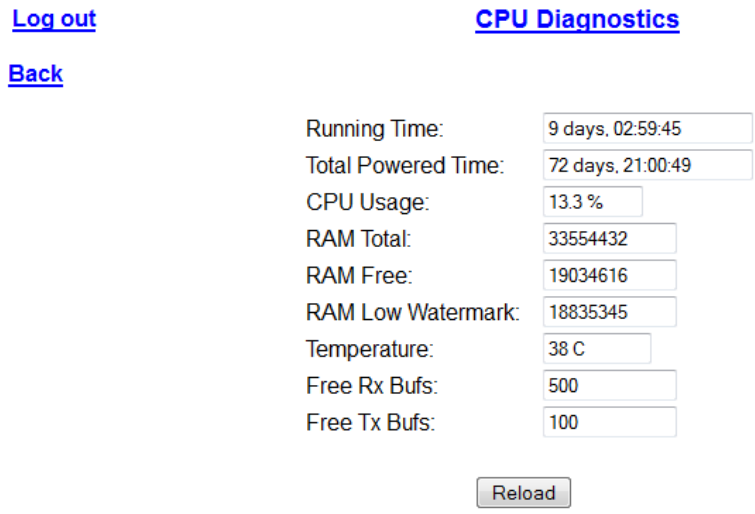


Figure 210: CPU Diagnostics Form

Parameter	Description
Running Time	**Synopsis:** DDDD days, HH:MM:SS The length of time since the device was last powered on.
Total Powered Time	**Synopsis:** DDDD days, HH:MM:SS The cumulative powered up time of the device.
CPU Usage	**Synopsis:** 0 to 100 The percentage of available CPU cycles used for device operation as measured over the last second.
RAM Total	**Synopsis:** 0 to 4294967295 The total number of bytes of RAM in the system.
RAM Free	**Synopsis:** 0 to 429496729 The total number of bytes of RAM still available.
RAM Low Watermark	**Synopsis:** 0 to 4294967295 The total number of bytes of RAM that have not been used during the system runtime.
Temperature	**Synopsis:** -32768 to 32767 C The temperature of the CPU board.
Free Rx Bufs	**Synopsis:** 0 to 4294967295 Free Rx Buffers.
Free Tx Bufs	**Synopsis:** 0 to 4294967295 Free Tx Buffers.

Section 14.3

Viewing and Clearing the System Log

The system log records various events including reboots, user sign-ins, alarms and configuration saves.

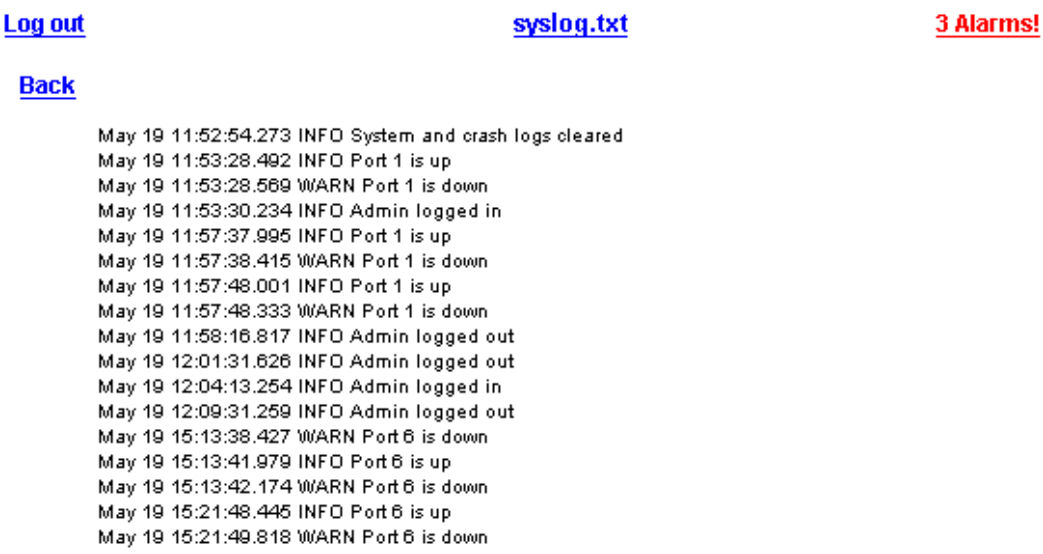

Log out
syslog.txt
3 Alarms!
Back
May 19 11:52:54.273 INFO System and crash logs cleared
May 19 11:53:28.492 INFO Port 1 is up
May 19 11:53:28.569 WARN Port 1 is down
May 19 11:53:30.234 INFO Admin logged in
May 19 11:57:37.995 INFO Port 1 is up
May 19 11:57:38.415 WARN Port 1 is down
May 19 11:57:48.001 INFO Port 1 is up
May 19 11:57:48.333 WARN Port 1 is down
May 19 11:58:16.817 INFO Admin logged out
May 19 12:01:31.626 INFO Admin logged out
May 19 12:04:13.254 INFO Admin logged in
May 19 12:09:31.259 INFO Admin logged out
May 19 15:13:38.427 WARN Port 6 is down
May 19 15:13:41.979 INFO Port 6 is up
May 19 15:13:42.174 WARN Port 6 is down
May 19 15:21:48.445 INFO Port 6 is up
May 19 15:21:49.818 WARN Port 6 is down

Figure 211: Viewing the System Log

The system log will continue to accumulate information until it becomes full. There is enough room in the file to accumulate logs for months or years under normal operation.

The Clear System Log option will clear the system log. Clearing the log is recommended after a firmware upgrade.

Section 14.4

Viewing Product Information

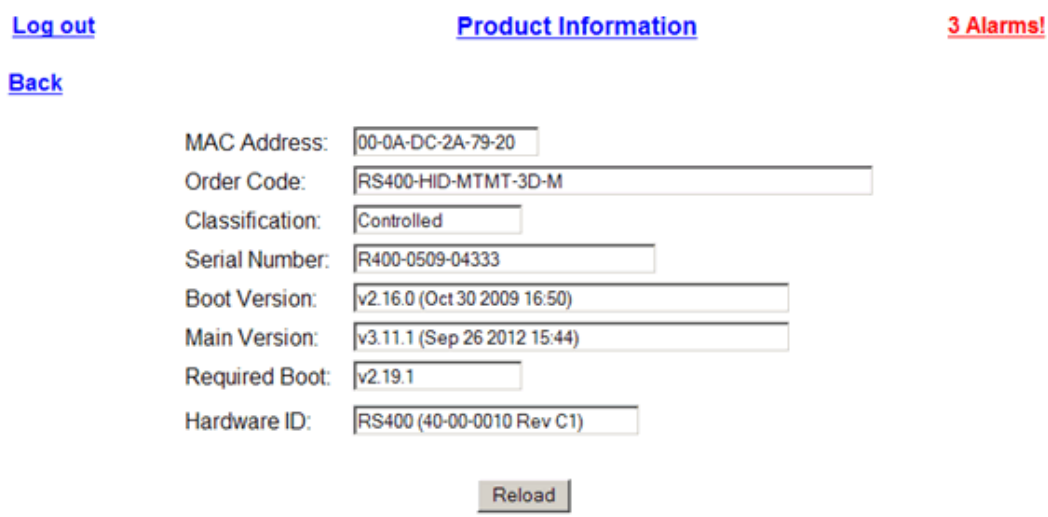


Figure 212: Product Information Form

Parameter	Description
MAC Address	**Synopsis:** ##-##-##-##-##-## where ## ranges 0 to FF Shows the unique MAC address of the device.
Order Code	**Synopsis:** Any 57 characters Shows the order code of the device.
Classification	**Synopsis:** Any 15 characters Provides system classification. The value 'Controlled' indicates the main firmware is a Controlled release. The value 'Non-Controlled' indicates the main firmware is a Non-Controlled release. The 'Controlled' main firmware can run on Controlled units, but it can not run on Non-Controlled units. The 'Non-Controlled' main firmware can run on both Controlled and Non-Controlled units.
Serial Number	**Synopsis:** Any 31 characters Shows the serial number of the device.
Boot Version	**Synopsis:** Any 47 characters Shows the version and the build date of the boot loader software.
Main Version	**Synopsis:** Any 47 characters Shows the version and build date of the main operating system software.
Required Boot	**Synopsis:** Any 15 characters Shows the minimum boot software loader version required by running main.
Hardware ID	**Synopsis:** { RSMCPU (40-00-0008 Rev B1), RSMCPU2 (40-00-0026 Rev A1), RS400 (40-00-0010 Rev B2), RMC30, RS900 (40-00-0025 Rev B1), RS900 (40-00-0032 Rev B1), RS1600M, RS400 (40-00-0010 Rev C1), RSG2100, RS900G, RSG2200, RS969, RS900 (v2, 40-00-0066), RS900 (v2, 40-00-0067), , RS416 (40-00-0078), RMC30 (v2), RS930 (40-00-0089), RS969 (v2, 40-00-0090), RS910 (40-00-0091-001 Rev A), RS920

Parameter	Description
	(40-00-0102-001 Rev A), RS940G (40-00-0097-000 Rev A), RSi80X series CPU board, RSG2300, RS416v2, ... } Shows the type, part number, and revision level of the hardware.

Section 14.5

Loading Factory Default Configuration

The Load Factory Defaults menu is used to reset the unit's configuration to its factory default. Optionally, it is possible to exclude parameters that affect basic connectivity and SNMP management from the reset in order to be able to remain in communication with the device. Specifically, configuration items in the following categories are *not* affected by a selective configuration reset:

- IP Interfaces
- IP Gateways
- SNMP Users
- SNMP Security to Group Maps
- SNMP Access
- RUGGEDCOM Discovery Protocol™ (RCDP)
- Time Zone
- DST Offset
- DST Rule

The menu presents a choice of whether to reset all or only the selected set of configuration parameters to their factory default values:

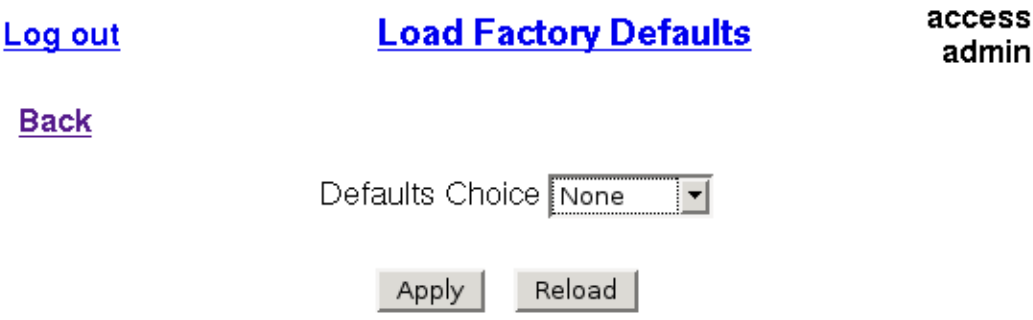


Figure 213: Load Factory Defaults Dialog

Parameter	Description
Defaults Choice	**Synopsis:** { None, Selected, All } This parameter allows the user to choose to load defaults to Selected tables (i.e. excluding those listed above), which would preserve configuration of the tables that are critical for basic communication and switch management applications, or to force All tables to default settings.

NOTE
It is possible to explicitly reset configuration items in the exceptional categories listed above to their default values by using the `sql` *command. Please refer to the section entitled: "Upgrading Firmware and Managing Configurations".*

Section 14.6
Resetting the Device

This operation will warm-start the device after the user has confirmed the reset operation from the Reset Device option.

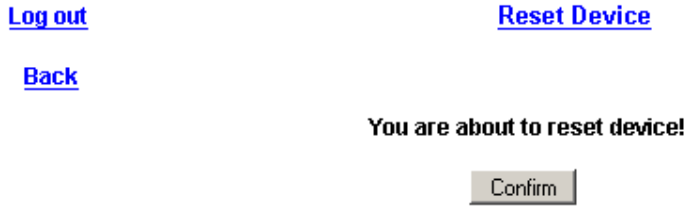


Figure 214: Reset Device Dialog

Section 14.7
Transferring Files

The Files Transfer form is used to transfer files between the device and a PC. To transfer files using this form, either a TFTP server must be installed and running on the PC, or a TELNET connection must be established with the device so that XMODEM can be used to transfer files.

If a TFTP server is installed and running on the PC, press **GET** to transfer from the PC to the device, or **PUT** to transfer from the device to the PC.

Available files include:

- main.bin (application software)
- boot.bin (boot software)
- config.csv (configuration file)
- syslog.txt (system log file)

NOTE
If the transfer is not completed within 1 minute, an error will be reported.

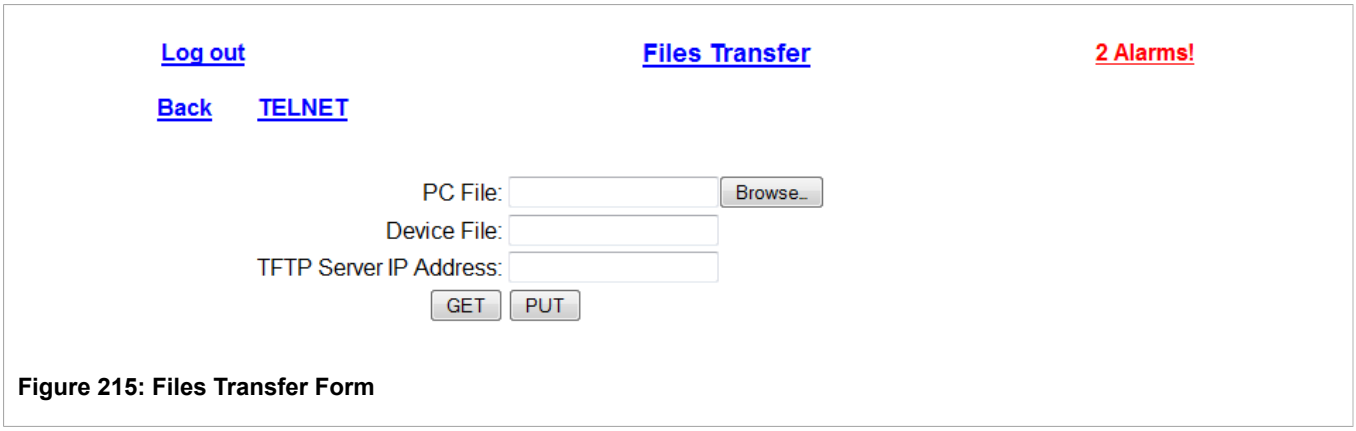


Figure 215: Files Transfer Form

Parameter	Description
PC File	The path and name of the file on your local PC. Use the Browse button to locate the file.
Device File	The name of the file on the device.
TFTP Server IP Address	The IP address of a TFTP server. A TFTP server application must be installed on your local PC.

15 Firmware Upgrade and Configuration Management

ROS provides flexible, powerful mechanisms for the bulk update and backup of system firmware and of the configuration database. The ROS firmware and configuration database are represented as files in the internal file system, and bulk update and backup consist of simply transferring files to and from the ROS device, by one of the several means provided.

ROS also implements an SQL command language in order to provide the flexibility and power of a database model when configuring ROS-based devices.

Section 15.1
Files Of Interest

The files in ROS that may be updated and backed up are described below:

- *main.bin*: the main ROS application firmware image – Upgrades to ROS are made via updates to this file.
- *boot.bin*: the boot loader firmware image – In normal practice, the boot loader does not require updating.
- *fpga.xsvf*: the FPGA firmware binary image – not normally updated.
- *fpga416.xsvf*: the firmware binary image for the secondary FPGA onboard the RS416 – not normally updated.
- *config.csv*: the complete configuration database, in the form of a comma-delimited ASCII text file.
- *banner.txt*: contains text that appears on the login screen.

Section 15.2
File Transfer Mechanisms

Several mechanisms are available to transfer these files to and from a ROS-based device:

- *XModem* using the ROS CLI over a (telnet or RS232) console session.
- *TFTP client* (using the ROS CLI in a console session and a remote TFTP server).
- *TFTP server* (from a remote TFTP client).
- *SFTP* (secure FTP over SSH, from a remote SFTP client).

Section 15.3
Console Sessions

Console sessions may be established (depending on the settings in the IP Services menu) by the following means:

- *RS232* direct RS232 serial connection to the ROS device.

- *telnet* remote terminal protocol via TCP/IP (unencrypted).
- *RSH* Remote SHell, the remote login shell protocol via TCP/IP (unencrypted).
- *SSH* Secure SHell, the standard remote login shell protocol via TCP/IP – Both authentication and session are encrypted.

Section 15.4
Upgrading Firmware

Upgrading ROS firmware may sometimes be necessary in order to take advantage of new features or bug fixes. In normal circumstances, only the main ROS application firmware is updated; the boot loader and FPGA firmware remain invariant. The main ROS application firmware image is a binary file available from Siemens. Please check the Siemens web site, www.siemens.com/ruggedcom, for the availability of updates to ROS firmware or contact Siemens support.

Firmware upgrades may be performed using any of the transfer methods and protocols listed in Section 15.2, “File Transfer Mechanisms”.

NOTE
If a Boot upgrade is required from Boot v2.15.0 or older, it is recommended to run the "flashfiles defrag" command from the CLI Shell prior to the bootloader upgrade.

IMPORTANT!
Non-Controlled (NC) versions of ROS can not be upgraded to Controlled firmware versions. However, Controlled firmware versions can be upgraded to an NC firmware version.

Section 15.4.1
Applying the Upgrade

Binary firmware images transferred to the ROS-based device are stored in non-volatile memory and require a device reset in order to take effect. The "version" ROS shell command will display any firmware updates that are pending. Currently running firmware is labeled "Current"; pending upgrades are labeled "Next":

```
>version
Current ROS-CF52 Boot Software v2.14.0 (Sep 29 2008 13:25)
Current ROS-CF52 Main Software v3.6.0 (Oct 03 2008 09:33)
Next    ROS-CF52 Main Software v3.7.0 (Jun 02 2009 08:36)
```

ROS firmware is provided as a compressed installation image. When this compressed image is run for the first time, it decompresses itself and reinstalls the decompressed image to Flash memory. Subsequent device reboots will use the decompressed image.

Section 15.4.2
Security Considerations

There are three file transfer methods available in ROS: XModem, TFTP and SFTP.

Any user can perform transfers from the device using XModem and TFTP. However, only users logged using the admin account can upload files to the device.

NOTE
TFTP does not define an authentication scheme. Any use of the TFTP client or server is considered highly insecure.

NOTE
XModem transfers can only be performed through the serial console, which is authenticated during login.

The device does not have an SFTP client and, therefore, can only receive SFTP files from an external source. SFTP requires authentication for the file transfer.

Section 15.4.3
Upgrading Firmware Using XModem

This method requires that the binary image file of the main ROS application firmware, along with serial terminal or telnet software and the ability to do XModem transfers, be available on a computer with an RS232 or network connection, respectively, to the ROS device to be upgraded.

Establish a console connection with administrative privileges, either via the RS232 port or via telnet. Enter the ROS command, "xmodem receive main.bin<CR>". When ROS responds with "Press Ctrl-X to cancel", begin your XModem transmission, using the means provided by your terminal software. After the file transfer has been completed, the device will provide an indication that the file has been transferred successfully. The transcript of a sample exchange, looking at the ROS CLI, follows:

```
>xmodem receive main.bin
Press Ctrl-X to cancel
Receiving data now ...C
Received 1428480 bytes. Closing file main.bin ...
main.bin transferred successfully
```

If possible, select the "XModem 1K" protocol for transmission; otherwise, select "XModem". The device must be reset in order for the new software to take effect. If you want to reset the device immediately, enter "reset<CR>". The device will reboot within a few seconds.

Section 15.4.4
Upgrading Firmware Using the ROS TFTP Server

This method requires that the binary image file of the main ROS application firmware, along with TFTP client software, be available on a computer with a network connection to the ROS device to be upgraded.

NOTE
The TFTP Server parameter in IP Services Configuration controls how a TFTP client can access the device's built-in TFTP server. A setting of "Disabled" prevents all access, "Get Only" allows retrieval of files only, and "Enabled" allows both storing and retrieval of files. Ensure that this parameter is set appropriately for the type of access you wish to perform.

Enable TFTP transfers to the ROS device, as noted above. Begin a TFTP transfer in binary mode to the device, specifying a destination filename of "main.bin". A TFTP client utility will provide an indication that the file was transferred properly, but it is recommended to also query the device directly in order to verify successful transfer. Establish a console session to the ROS device (using RS232, telnet, or SSH) and enter the "version" command,

as described in Applying the Upgrade, above. If the transfer was successful, the version of the firmware file that was transferred will appear as the "Next" firmware version, i.e. that will appear after the next reset.

The transcript of a sample TFTP transfer, looking at a DOS/Windows CLI, follows:

```
C:\>tftp -i 10.1.0.1 put C:\files\ROD-CF52_Main_v3.7.0.bin main.bin
Transfer successful: 1428480 bytes in 4 seconds, 375617 bytes/s
```

Section 15.4.5

Upgrading Firmware Using the ROS TFTP Client

This method requires that the binary image file of the main ROS application firmware, along with a correctly configured TFTP server, be available on a computer with a network connection to the ROS device to be upgraded.

Identify the IP address of the host providing the TFTP server capability. Ensure that the firmware revision to be downloaded (e.g. ROS-CF52_Main_v3.7.0.bin) is present there. Establish a console connection with administrative privileges to the ROS device to be upgraded (i.e. via RS232, telnet, or SSH). Enter the CLI shell and run the TFTP client command to receive the firmware image, for example:

```
tftp <TFTP server> get <remote filename> main.bin
```

where:

- *TFTP server* is the IP address of the TFTP server
- *remote filename* is the name of the binary image file of the main ROS application firmware residing in the TFTP server outgoing directory

Verify, as above, the successful transfer via the ROS CLI "version" command. A sample transcript from the ROS CLI:

```
>tftp 10.0.0.1 get ROS-CF52_Main_v3.7.0.bin main.bin
TFTP CMD: main.bin transfer ok. Please wait, closing file ...
TFTP CMD: main.bin loading succesful.

>version
Current ROS-CF52 Boot Software v2.14.0 (Sep 29 2008 13:25)
Current ROS-CF52 Main Software v3.6.0 (Oct 03 2008 09:33)
Next    ROS-CF52 Main Software v3.7.0 (Jun 02 2009 08:36)
```

Section 15.4.6

Upgrading Firmware Using SFTP

This method requires that the binary image file of the main ROS application firmware, along with SFTP client software, be available on a computer with a network connection to the ROS device to be upgraded. SFTP is the Secure File Transfer Protocol (also known as the SSH File Transfer Protocol), a file transfer mechanism that uses SSH to encrypt every aspect of file transfer between a networked client and server.

Establish an SFTP connection with administrative privileges to the ROS device to be upgraded. Begin a transfer to the device, specifying a destination filename of "main.bin". An SFTP client utility will provide an indication that the file was transferred properly, but, again, it is recommended to also query the device directly in order to verify successful transfer. A sample SFTP session to upgrade the ROS main firmware image from a Linux workstation follows:

```
user@host$ sftp admin@ros_ip
```

```
Connecting to ros_ip...
admin@ros_ip's password:
sftp> put ROS-CF52_Main_v3-7-0.bin main.bin
Uploading ROS-CF52_Main_v3-7-0.bin to /main.bin
ROS-CF52_Main_v3-7-0.bin               100% 2139KB  48.6KB/s   00:44
sftp>
```

Section 15.5

Downgrading Firmware

Downgrading the ROS firmware is generally not recommended, as it may have unpredicatable effects. However, if a downgrade is required, do the following:

IMPORTANT!
Before downgrading the firmware, make sure the hardware and FPGA code types installed in the device are supported by the older firmware version. Refer to the Release Notes for the older firmware version to confirm.

IMPORTANT!
Non-Controlled (NC) versions of ROS can not be downgraded to Controlled firmware versions. However, Controlled firmware versions can be downgraded to an NC firmware version.

CAUTION!
Do not downgrade the ROS boot version.

1. Disconnect the device from the network.
2. Connect to the device either through the serial console port or through the device's IP address.
3. Log in as an adminstrator.
4. Make a local copy of the current configuration file.

   IMPORTANT!
   Never downgrade the ROS software version beyond ROS v when encryption is enabled. Make sure the device has been restored to factory defaults before downgrading.
5. Restore the device to its factory defaults.
6. Upload and apply the older firmware version and its associated FPGA files using the same methods used to install newer firmware versions. For more information , refer to Section 15.4, “Upgrading Firmware”.
7. Clear all logs by issuing the "clearlogs" command.
8. Clear all alarms by issuing the "clearalarms" command.
9. Configure the device as desired.

After downgrading the firmware and FPGA files, note the following:

- Some settings from the previous configuration may be lost or loaded to default (including user’s passwords if downgrading from a security related version), as those particular tables or fields may not exist in the older firmware version. Because of this, the unit must be configured after the downgrade.
- A standard banner will appear on the login screen instead of a custom banner.

Section 15.6

Updating Configuration

By default, ROS maintains its complete configuration in an ASCII text file, in CSV (Comma-Separated Value) format. The file can also be encrypted and assigned a passphrase key for protection. All configuration changes, whether they are performed using the web interface, console interface, CLI, SNMP, or SQL, are stored in this one file. The file, named *config.csv*, may be read from and written to the ROS device in the same ways that firmware image files can, as described in the preceding sections. The configuration file may be copied from the unit and used as a backup, to be restored at a later date. Configuration files from different units may be compared using standard text processing tools.

For more information about encrypting the configuration file, refer to Section 2.8, “Data Storage”.

NOTE

Data encryption is not available in NC versions of ROS.

When switching between Controlled and Non-Controlled (NC) versions of ROS, make sure data encryption is disabled. Otherwise, the NC version of ROS will ignore the encrypted configuration file and load the factory defaults.

The transfer mechanisms supported for the update of *config.csv* are the same as for ROS firmware image files:

- *XModem* using the ROS CLI over a console session.
- *TFTP client* (using the ROS CLI in a console session and a remote TFTP server).
- *TFTP server* (from a remote TFTP client).
- *SFTP* (secure FTP over SSH, from a remote SFTP client).

Please refer to the preceding section, Section 15.4, “Upgrading Firmware”, for examples of the use of each of these mechanisms for transferring a file to a ROS device.

Once a configuration file has been successfully transferred, it is automatically applied.

Configuration File Format

The format of the configuration file makes it simple to apply a wide variety of tools to the task of maintaining ROS configuration. Among the applications that may be used to manipulate ROS configuration files are:

- Any text editing program capable of reading and writing ASCII files.
- Difference/patching tools (e.g. the UNIX "diff" and "patch" command line utilities).
- Source Code Control systems (e.g. CVS, SVN).

CAUTION!

Do not edit an encrypted configuration file. Any line that has been modified manually will be ignored.

ROS also has the ability to accept partial configuration updates. It is possible, for example, to update only the parameters for a single Ethernet port. Transferring a file containing only the following lines to a ROS device will result in an update of the parameters for Ethernet port 1 without changing any other parameters of the device’s configuration:

```
# Port Parameters
ethPortCfg
Port,Name,Media,State,AutoN,Speed,Dupx,FlowCtrl,LFI,Alarm,
1,Port 1,100TX,Enabled,On,Auto,Auto,Off,Off,On,
```

Security Considerations

The same limitations apply to writing *config.csv* to the ROS device that apply to firmware images. Refer to Section 15.4, “Upgrading Firmware” for details on the permissions necessary to write the ROS configuration file.

Section 15.7

Backing Up ROS System Files

All of the same file transfer mechanisms discussed in the preceding sections may also be used to transfer files *from* a ROS device, as well as to update firmware or configuration files. It might be desirable, in addition to creating an archive of the device’s firmware files, to back up the configuration database, *config.csv*, or system log file, *syslog.txt*, on a regular basis. Type "dir" at the ROS CLI for a listing and description of files on the ROS device.

An example of backing up a file using SFTP follows. For descriptions on the use of the other file transfer mechanisms, please refer to the examples in Section 15.4, “Upgrading Firmware”. Note that only the direction of file transfer changes.

Section 15.7.1

Backing Up Files Using SFTP

This method requires that SFTP client software be available on a computer with a network connection to the ROS device that one wishes to back up. Establish an SFTP connection with administrative privileges to the ROS device. Begin transferring the desired file from the device. An example of using an SFTP session to create a local backup of the ROS main firmware image to a Linux workstation follows:

```
user31host$ sftp admin31ros_ip
Connecting to ros_ip...
admin31ros_ip's password:
sftp> get main.bin
Downloading /main.bin
main.bin                                    100% 2139KB  48.7KB/s   00:44
sftp>
```

All files in ROS may be backed up using an SFTP session with administrative privileges.

Section 15.8

Certificate and Key Management

Users are able to load custom and unique SSL certificates and SSL/SSH keys in ROS or use the certificates and keys provided by ROS.

There are three types of certificates and keys:

NOTE
Default and auto-generated SSH keys are not available for Non-Controlled (NC) versions of ROS.

- **Default**

Each ROS device is shipped with an SSL certificate and RSA key pair, and a DSA key pair for SSH that are unique to software version. If a valid SSL certificate or SSL/SSH keys are not available on the device, the default certificate and keys are used immediately so that SSH and SSL (https) sessions can be served.

- **Auto-Generated**

  If a default SSL certificate and SSL/SSH keys are in use, ROS immediately begins to generate a unique certificate and SSL/SSH keys for the device in the background. This process takes approximately one hour to complete (depending on how busy the device is at the time) following the startup of the device. If a custom certificate and keys are loaded while auto-generated certificates and keys are being generated, the generator will abort and the custom certificate and keys and will be used.

- **User-Generated (Recommended)**

  Custom certificates and keys are the most secure option. They give the user complete control over certificate and key management, allow for certificates signed by a public or local certificate authority, controlled distribution of public SSH keys to network hosts that need them, and more.

NOTE
The RSA key pair must be added to the `ssl.crt` *file after the SSL certificate.*

For SSL, ROS requires an X.509 certificate in standard PEM format and an RSA key pair. The certificate may be self-signed or signed by a separate authoriy. The RSA key must be between 512 and 1048 bits in length. The certificate and keys must be combined in a single `ssl.crt` file and uploaded to the device.

The following is an example of a combined SSL certificate and key:

```
-----BEGIN CERTIFICATE-----
MIIC9jCCAl+gAwIBAgIJAJh6rrehMt3iMA0GCSqGSIb3DQEBBQUAMIGuMQswCQYD
VQQGEwJDQTEQMA4GA1UECBMHT250YXJpbzEQMA4GA1UEBxMHQ29uY29yZDESMBAG
A1UEChMJUnVnZ2VkY29tMRkwFwYDVQQLExBDdXN0b21lciBTdXBwb3J0MSYwJAYD
VQQDEx1XUy1NSUxBTkdPVkFOLlJVR0dFRENPTS5MT0NBTDEkMCIGCSqGSIb3DQEJ
ARYVc3VwcG9ydEBydWdnZWRjb20uY29tMB4XDTEyMTAyMzIxMTA1M1oXDTE3MTAy
MjIxMTA1M1owgZwxCzAJBgNVBAYTAlVTMRAwDgYDVQQIEwdPbnRhcmlvMRAwDgYD
VQQHEwdDb25jb3JkMRIwEAYDVQQKEwlSdWdnZWRDb20xGTAXBgNVBAsTEEN1c3Rv
bWVyIFN1cHBvcnQxFDASBgNVBAMTCzE5Mi4xNjguMS4yMSQwIgYJKoZIhvcNAQkB
FhVTdXBwb3J0QHJ1Z2dlZGNvbS5jb20wgZ8wDQYJKoZIhvcNAQEBBQADgY0AMIGJ
AoGBALfE4eh2aY+CE3W5a4Wz1Z1RGRP02COHt153wFFrU8/fFQXNhKlQirlAHbNT
RSwcTR8ZFapivwYDivn0ogOGFXknYP90gv2oIaSVY08FqZkJW77g3kzkv/8Zrw3m
W/cBsZJ8SyKLIDfy401HkHpDOle5NsQFSrziGUPjAOIvvx4rAgMBAAGjLDAqMAkG
A1UdEwQCMAAwHQYDVR0OBBYEFER0utgQOifnrflnDtsqNcnvRB0XMA0GCSqGSIb3
DQEBBQUAA4GBAHtBsNZuh8tB3kdqR7Pn+XidCsD70YnI7w0tiy9yiRRhARmVXH8h
5Q1rOeHceri3JFFIOxIxQt4KgCUYJLu+c9Esk/nXQQar3zR7IQCt0qOABPkviiY8
c3ibVbhJjLpR2vNW4xRAJ+HkNNtBOg1xUlp4vOmJ2syYZR+7XAy/OP/S
-----END CERTIFICATE-----
-----BEGIN RSA PRIVATE KEY-----
MIICXAIBAAKBgQC3xOHodmmPghN1uWuFs9WdURkT9Ngjh7ded8BRa1PP3xUFzYSp
UIq5QB2zU0UsHE0fGRWqYr8GA4r59KIDhhV5J2D/dIL9qCGklWNPBamZCVu+4N5M
5L//Ga8N5lv3AbGSfEsiiyA38uNNR5B6QzpXuTbEBUq84hlD4wDiL78eKwIDAQAB
AoGBAI2CXHuHg23wuk9zAusoOhw0MN1/M1jYz0k9aajIvvdZT3Tyd29yCADy8GwA
eUmoWXLS/C4CcBqPa9til8ei3rDn/w8dveVHsi9FXjtVSYqN+ilKw+moMAjZy4kN
/kpdpHMohwv/909VWR1AZbr+YTxaG/++tKl5bqXnZl4wHF8xAkEA5vwut8USRg2/
TndOt1e8ILEQNHvHQdQr2et/xNH4ZEo7mqot6skkCD1xmxA6XG64hR3BfxFSZcew
Wr4SOFGCtQJBAMurr5FYPJRFGzPM3HwcpAaaMIUtPwNyTtTjywlYcUI7iZVVfbdx
4B7qOadPybTg7wqUrGVkPSzzQelz9YCSSV8CQFqpIsEYhbqfTLZEl83YjsuaE801
xBivaWLIT0b2TvM2O7zSDOG5fv4I990v+mgrQRtmeXshVmEChtKnBcm7HH0CQE6B
2WUfLArDMJ8hAoRczeU1nipXrIh5kWWCgQsTKmUrafdEQvdpT8ja5GpX2Rp98eaU
NHfI0cP36JpCdome2eUCQDZN9OrTgPfeDIXzyOiUUwFlzS1idkUGL9nH86iuPnd7
WVF3rV9Dse30sVEk63Yky8uKUy7yPUNWldG4U5vRKmY=
-----END RSA PRIVATE KEY-----
```

For SSH, ROS requires a DSA key pair in PEM format. The DSA key must be between 512 and 2048 bits in length for Controlled versions. The key file is uploaded to the `ssh.keys` flash file on the device.

The following is an example of a PEM formatted SSH key:

```
-----BEGIN DSA PRIVATE KEY-----
MIIBuwIBAAKBgQD0gcGbXx/rrEMu2913UW4cYo1OlcbnuUz7OZyd2mBLDx/GYbD8
X5TnRcMraJ0RuuGK+chqQJW5k3zQmZa/BS6q9U7wYwIAx8JSxxpwfPfl/t09VwKG
rtSJIMpLRoDq3qEwEVyR4kDUo4LFQDsljtiyhcz1n6kd6gqsd5Xu1vdh4wIVANXb
SBi97GmZ6/9f4UCvIIBtXLEjAoGAAfmhkcCCEnRJitUTiCE+MurxdFUr3mFs/d31
4cUDaLStQEhYYmx5dbFdQuapl4Y32B7lZQkohi5q1T1iUAa40/nUnJx1hFvblkYT
8DLwxcuDAaiu0VqsaPtJ+baL2dYNp96tFisj/475PEEWBGbP6GSe5kKa1Zdgwuie
9LyPb+ACgYBv856v5tb9UVG5+tX5Crfv/Nd8FFlSSFKmVWW3yzguhHajg2LQg8UU
sm1/zPSwYQ0SbQ9aOAJnpLc2HUkK0lji/0oKVI7y9MMc4B+bGu4W4OnryP7oFpnp
YYHt5PJY+zvLw/Wa+u3NOVFHkF1tGyfVBMXeV36nowPo+wrVMolAEgIVALLTnfpW
maV6uh6RxeE1d4XoxSg2
-----END DSA PRIVATE KEY-----
```

Certificates and keys are uploaded using the same file transfer mechanisms discussed in previous sections.

Please refer to Section 1.1, “Security Considerations” for a detailed discussion of encryption key management.

Section 15.9

Using SQL Commands

The ROS provides an "SQL-like" command facility that allows expert users to perform several operations not possible under the user interface, namely:

- Restoring the contents of a specific table, but not the whole configuration, to their factory defaults.
- Search tables in the database for specific configurations.
- Make changes to tables predicated upon existing configurations.

When combined with RSH, SQL commands provide a means to query and configure large numbers of devices from a central location.

Section 15.9.1

Getting Started

SQL information is obtainable via the CLI shell "SQL" command:

```
>sql

The SQL command provides an 'sql like' interface for manipulating all system
configuration and status parameters. Entering 'SQL HELP command-name' displays
detailed help for a specific command. Commands, clauses, table, and column
names are all case insensitive.
DEFAULT   Sets all records in a table(s) to factory defaults.
DELETE    Allows for records to be deleted from a table.
HELP      Provides help for any SQL command or clause.
INFO      Displays a variety of information about the tables in the database
INSERT    Allows for new records to be inserted into a table.
SAVE      Saves the database to non-volatile memory storage.
SELECT    Queries the database and displays selected records.
UPDATE    Allows for existing records in a table to be updated.
```

Section 15.9.2
Finding the Correct Table

Many SQL commands operate upon specific tables in the database, and require the table name to be specified. Navigating the menu system to the desired menu and pressing <Ctrl-Z> will show the name of the table. The menu name and the corresponding database table name will be cited.

Another way to find a table name is to run the "sql info tables" command. This command also displays menu names and their corresponding database table names depending upon the features supported by the device:

```
Table                    Description
-------------------------------------------------------------------------------
alarms                   Alarms
cpuDiags                 CPU Diagnostics
ethPortCfg               Port Parameters
ethPortStats             Ethernet Statistics
ethPortStatus            Port Status
ipIfCfg                    IP Services
```

Section 15.9.3
Retrieving Information

Retrieving a Table

The SQL select subcommand is used to retrieve table information. The command, "sql select from ‘tablename’", provides a summary of the parameters within the table, as well as their values:

```
>sql select from ipIfCfg

Type ID   Mgmt IP Address Type IP Address      Subnet          IfIndex
VLAN 1    Yes  Static          192.168.0.54    255.255.255.0   1001

1 records selected
```

Retrieving a Parameter from a Table

SQL select command may be used to retrieve a particular parameter from a table. SQL command "sql select parameter_name from tablename" is used for this purpose. The parameter name is always the same as those displayed in the menu system. If the parameter name has spaces in it (e.g. "IP Address") the spaces must be replaced with underscores or the name must be quoted:

```
>sql select "ip address" from ipIfCfg

IP Address
192.168.0.8

1 records selected
```

Retrieving a Table with the ‘Where’ Clause

It is useful to be able to display specific rows of a table predicated upon the row having parameters of a specific value. Addition of "where" clause to the "select" statement will limit the results returned. For example, suppose that it is desirable to identify all ports on the device operating in Auto Select mode:

```
>sql select from ethportcfg where Speed = Auto

Port Name            ifName          Media       State    AutoN Speed Dupx  FlowCtrl LFI Alarm
1    Port 1          1               100TX       Enabled  On    Auto  Auto  Off      Off On
2    Port 2          2               100TX       Enabled  On    Auto  Auto  Off      Off On
```

```
3    Port 3          3               100TX       Enabled  On    Auto  Auto  Off      Off On
4    Port 4          4               100TX       Enabled  On    Auto  Auto  Off      Off On
5    Port 5          5               100TX       Enabled  On    Auto  Auto  Off      Off On
6    Port 6          6               100TX       Enabled  On    Auto  Auto  Off      Off On
7    Port 7          7               100TX       Enabled  On    Auto  Auto  Off      Off On
8    Port 8          8               100TX       Enabled  On    Auto  Auto  Off      Off On

8 records selected
```

It is also possible to select rows based on multiple parameters using "and" and "or" operations between comparisons in the "where" clause. For example:

```
>sql select from ethportcfg where Speed = Auto and FlowCtrl = On

Port Name            ifName          Media       State    AutoN Speed Dupx  FlowCtrl LFI Alarm
4    Port 4          4               100TX       Enabled  On    Auto  Auto  On       Off On
5    Port 5          5               100TX       Enabled  On    Auto  Auto  On       Off On

2 records selected
```

Section 15.9.4
Changing Values in a Table

The "where" clause can be used to select rows in a table and to modify the fields in that row. As an example, suppose that it is desirable to identify all ports on the device operating in 100 Mbps full-duplex mode with flow control disabled, and to enable flow control on these ports:

```
>sql update ethportcfg set FlowCtrl = Off where ( Media = 100TX and FlowCtrl = On )
2 records updated
```

Section 15.9.5
Setting Default Values in a Table

It is sometimes desirable to restore one table to its factory defaults without modifying the remainder of the configuration. The "sql default" command allows an individual table to be defaulted.

```
>sql default into ethportcfg
```

Section 15.9.6
Using RSH and SQL

The combination of remote shell scripting and SQL commands offers a means to interrogate and maintain a large number of devices. Consistency of configuration across sites may be verified by this method. The following presents a simple example where the devices to interrogate are drawn from the file "Devices":

```
C:> type Devices
10.0.1.1
10.0.1.2
10.0.1.3

c:\> for /F %i in (devices) do rsh %i -l admin,admin sql select from ethportcfg where flow_control =
 disabled
```

```
C:\>rsh 10.0.1.1 -l admin,admin sql select from ethportcfg where flow_control = disabled

Port Name            Status   Media Type  Flow Control FEFI     Link Alarms
5    Port 5          Enabled  Auto Select Disabled     Disabled Enabled

1 records selected

C:\>rsh 10.0.1.2 -l admin,admin sql select from ethportcfg where flow_control = disabled

0 records selected

C:\>rsh 10.0.1.3 -l admin,admin sql select from ethportcfg where flow_control = disabled

Port Name            Status   Media Type  Flow Control FEFI     Link Alarms
3    Port 3          Enabled  Auto Select Disabled     Disabled Enabled
7    Port 7          Enabled  Auto Select Disabled     Disabled Enabled
8    Port 8          Enabled  Auto Select Disabled     Disabled Enabled
13   Port 13         Enabled  Auto Select Disabled     Disabled Enabled

4 records selected

C:\
```